TRANSNASAL HUMIDIFIED RAPID-INSUFFLATION VENTILATORY EXCHANGE VERSUS CONVENTIONAL FACEMASK BREATHING FOR PREOXYGENATION DURING RAPID SEQUENCE INDUCTION IN ADULTS: A PROSPECTIVE RANDOMIZED STUDY

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Submitted By

DR DIKSHA

DEPARTMENT OF ANAESTHESIOLOGY
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA, PUNJAB

DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled "**TRANSNASAL HUMIDIFIED RAPID-INSUFFLATION VENTILATORY EXCHANGE VERSUS CONVENTIONAL FACEMASK BREATHING FOR PREOXYGENATION DURING RAPID SEQUENCE INDUCTION IN ADULTS: A PROSPECTIVE RANDOMIZED STUDY**" submitted towards partial fulfillment of the requirements for the award of **MD in Anaesthesiology** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Anju Grewal**, Former Professor & Head, Department of Anaesthesiology, **Dr. Kamakshi Garg**, Professor, Department of Anaesthesiology, **Dr. Richa Jain**, Associate Professor, Department of Anaesthesiology. No part of this thesis has formed the basis for the award of any degree previously.

_____

Dr. Diksha
Department of Anaesthesiology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab

Date:

Place:

CERTIFICATE OF SUPERVISORS

This is to certify that the work incorporated in this thesis entitled "**TRANSNASAL HUMIDIFIED RAPID-INSUFFLATION VENTILATORY EXCHANGE VERSUS CONVENTIONAL FACEMASK BREATHING FOR PREOXYGENATION DURING RAPID SEQUENCE INDUCTION IN ADULTS: A PROSPECTIVE RANDOMIZED STUDY"** has been carried out by **Dr. Diksha** under our direct supervision. The data incorporated in this thesis is original and genuine and has been carried out by the candidate herself.

Signature of Supervisor

Dr. Anju Grewal
Former Professor & Head
Department of Anaesthesiology
DMC&H, Ludhiana

Signature of Co-Supervisors

Dr. Kamakshi Garg
Professor
Department of Anaesthesiology
DMC&H, Ludhiana

Dr. Richa Jain
Associate Professor
Department of Anaesthesiology
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE INSTITUTE

This is to certify that the thesis entitled "**TRANSNASAL HUMIDIFIED RAPID-INSUFFLATION VENTILATORY EXCHANGE VERSUS CONVENTIONAL FACEMASK BREATHING FOR PREOXYGENATION DURING RAPID SEQUENCE INDUCTION IN ADULTS: A PROSPECTIVE RANDOMIZED STUDY"** is a bonafide research work done by **Dr. Diksha** under the supervision of **Dr. Anju Grewal**, Former Professor & Head, Department of Anaesthesiology, **Dr. Kamakshi Garg**, Professor, Department of Anaesthesiology and **Dr. Richa Jain**, Associate Professor, Department of Anaesthesiology and in this institution.

Principal

Dr. Sandeep Puri
Principal
DMC&H, Ludhiana

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Signature

Dr Diksha
Department of Anaesthesiology,
Dayanand Medical College & Hospital,
Ludhiana, Punjab - 141001

Date:

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Dedicated

to

my Family

&

Teachers

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Dr. DIKSHA

ABBREVIATIONS

ETN_2	End tidal nitrogen
EtO_2	End tidal oxygen
FAN_2	Fraction of alveolar nitrogen
FAO_2	Fraction of alveolar Oxygen
FGF	Fresh gas flows
FiO_2	Fraction of inspired oxygen
GA	General anaesthesia
HFNC	High flow nasal cannula
HFNO	High flow nasal oxygen
NIPPV	Non-invasive positive-pressure ventilation
$PaCO_2$	Partial pressure of arterial carbon dioxide
PaO_2	Partial pressure of arterial oxygen
PEEP	Positive end-expiratory pressure
RSI	Rapid sequence induction
SaO_2	Oxyhemoglobin desaturation
SpO_2	Peripheral oxygen saturation
SVCB	Single vital capacity breath
THRIVE	Transnasal Humidified Rapid-Insufflation Ventilatory Exchange
TVB	Tidal volume breathing

ABSTRACT

Introduction: Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE) if used for pre-oxygenation and apnoeic oxygenation has the propensity to extend the safe apnoea time and thereby decreasing the incidence of desaturation during Rapid Sequence Induction (RSI) for emergency surgeries. Hence, we proposed to evaluate the comparative efficacy of pre-oxygenation with use of conventional facemask breathing versus THRIVE during RSI in patients undergoing general anaesthesia (GA) for emergency surgeries.

Aims & objectives: To compare partial pressure of arterial oxygen (PaO_2) and the lowest peripheral oxygen saturation (SpO_2) between two groups.

Material & Methods: Patients undergoing RSI under GA for emergency abdomino-pelvic surgery were allocated randomly into two groups. Patients were preoxygenated for 3 minutes with 100% oxygen either via a high flow nasal cannula at flow of 60 L/min using THRIVE or via a tightly held snuggly fitting facemask at flow of 12L/min using a circle system. RSI was administered followed by laryngoscopy and endotracheal intubation. PaO_2 was measured immediately after successful endotracheal intubation as it was our primary outcome. The lowest SpO_2, apnoea time, number of attempts at laryngoscopy, use of any rescue manoeuvres and any adverse event were also recorded. Data thus collected was statistically analysed.

Results: No statistically significant difference in PaO_2 value after successful intubation, lowest SpO_2, apnoea time ,number of attempts at laryngoscopy,use of any rescue manoeuvres and adverse event was found between both the groups .

Conclusion: we conclude that though not superior to conventional face mask, THRIVE is a safe, practicable and efficient pre-oxygenation tool during rapid sequence induction of general anaesthesia for patients undergoing emergency surgeries.

Keywords: THRIVE (Transnasal Humidified Rapid-Insufflation Ventilatory Exchange), HFNC (high flow nasal cannula), Preoxygenation, Rapid Sequence Induction (RSI).

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INTRODUCTION

Rapid sequence induction (RSI) is routinely performed for patients undergoing emergency surgeries, which can be a challenging situation for an anaesthesiologist because of the potential physiological and pathological derangements in these patients.[1,2] These physiological derangements predispose towards a higher risk for developing hypoxia during RSI thereby limiting the safety margins during attempts to secure a definitive airway. Therefore, preoxygenation is mandatory for these critically ill patients as it not only denitrogenates the lungs but also increases the O_2 reservoir in the lungs thereby prolonging the safe apnoea period and reducing intubation related oxyhaemoglobin desaturation.[3]

The effectiveness of pre-oxygenation is assessed by its efficacy and efficiency. Efficacy of pre-oxygenation is determined by increase in the fraction of alveolar O2 (FAO_2), decrease in the fraction of alveolar nitrogen (FAN_2), and increase in arterial oxygen tension (PaO_2). Efficiency of pre-oxygenation is assessed from the decline of oxyhemoglobin desaturation (SaO_2) during apnoea (cessation of breathing or ventilation).[4] Factors like fraction of inspired oxygen (FiO_2), duration of preoxygenation, and the alveolar ventilation/functional residual capacity ratio affects the efficacy and efficiency of pre-oxygenation.[4]

Various techniques commonly used for preoxygenation with facemask include tidal volume breathing (TVB), deep breathing and positive airway pressure. The traditional method of TVB with 100% oxygen for 3 to 5 minutes technique for preoxygenation with fresh gas flows(FGF) ranging from 5 to 35 L/min have been successfully used for preoxygenation.[5] The other method which was used by Gold and colleagues is deep breathing in which patient is asked to take 4 deep breaths in 30 seconds, based on the assumption that alveolar denitrogenation can be achieved rapidly by deep breathing.[6] However, this method was found to be inferior to tidal volume breathing due to rebreathing of exhaled nitrogen and a decreased FiO_2.[7] Therefore, the

duration of deep breathing was extended to 1, 1.5 and 2 minutes (to allow 8, 12, and 16 deep breaths respectively) along with use of high FGF (≥10 L/min) to achieve maximal preoxygenation (evidenced by higher EtO_2, PaO_2, and lower EtN_2) and to improve efficiency (evidenced by delay in onset of oxyhemoglobin desaturation during apnea).[8,9] A single vital capacity breath (SVCB) technique over 30 seconds used for preoxygenation, also resulted in a PaO_2 comparable to that achieved by TVB for 3 minutes.[10]

Lately, the use of non-invasive positive-pressure ventilation (NIPPV) with positive end-expiratory pressure (PEEP) with 100% oxygen in the reverse Trendelenburg position has been recommended to maximize preoxygenation in obese and/or critically ill patients.[11,12] By increasing mean airway pressure, NIV with PEEP recruits alveoli that contribute to increased right-to-left shunt in vulnerable patient populations.[12]

Current practice employs the use of tidal volume breathing with conventional facemask for preoxygenation for 3 minutes at flow rates of oxygen upto 15L/min. With maximal preoxygenation, the time to oxyhemoglobin desaturation below 80% can vary from 9 minutes in healthy non-obese adults to 3 minutes or less in children or obese adults.[13]Patients undergoing emergency surgeries are usually full stomach, hence ventilation with conventional facemask during period of desaturation can increase the risk of gastric insufflation and pulmonary aspiration.[13] The combination of poor physiological reserves and risk of pulmonary aspiration mandates use of apnoeic ventilation along with optimal pre-oxygenation for safer conduct of RSI.

Conventionally facemask preoxygenation along with use of nasal cannula for apnoeic ventilation at flow rates of >15L/minute can result in patient discomfort, mucosal dryness and headaches.[14] In addition, this flow may not be adequate in maintaining oxygenation during RSI of these critically ill patients. [14]

Transnasal Humidified Rapid-insufflation Ventilatory Exchange (THRIVE) has been recommended as an alternative method for preoxygenation and apnoeic oxygenation during RSI. THRIVE can deliver heated and humidified oxygen with FiO2 ranging from 21% to

100% and flows upto 60-70L/min through specially designed high flow nasal cannula (HFNC).[15]

Recently, few studies compared conventional facemask and THRIVE as a method for preoxygenation in RSI in terms of safe apnoea time, PaO_2,$PaCO_2$,SPO_2 and other hemodynamic variables.

In a study conducted by Patel et al THRIVE was used for both pre-oxygenation and apnoeic oxygenation in patients with features of difficult airway undergoing general anaesthesia for hypolaryngeal and orolaryngeal surgeries. They observed an extended median apnoeic period upto 14 minutes without any incidence of desaturation. They concluded that THRIVE extends the benefits of classic facemask preoxygenation and provides continuous positive airway pressure gaseous exchange through flow dependent dead space flushing. [14]

Mir et al. compared preoxygenation with conventional facemask and THRIVE in 40 patients undergoing RSI for emergency surgery and they observed that PaO2 was similar in both the groups in spite of a significantly longer apnoea time in THRIVE group. [16] Later, Lodenius et al also compared the preoxygenation method with conventional facemask and THRIVE in adult patients who required RSI for emergency surgery and reported lower number of patients desaturating below 93% in the group preoxygenated with THRIVE. [17]

In 2021, Zhen hua et al conducted comparative study for preoxygenation with conventional facemask and THRIVE in 60 elderly (65yr-80yr) ASA grade I-III patients requiring tracheal intubation or the application of laryngeal mask under general anaesthesia. Apnoea time was considered from cessation of spontaneous breathing uptil SpO2 less than 90% or uptil 10 minutes from that. The apnoea time was found to be significantly prolonged in the THRIVE group. There was no significant difference found of PaO_2, $PaCO_2$ and vitals between the two groups.[18]

Thus incorporation of THRIVE for pre-oxygenation and continued oxygenation during apnoeic period might offer superior conditions during RSI.

Based on the conclusions from above mentioned studies, we

hypothesized that the use of THRIVE at 60L/min for preoxygenation and apnoeic oxygenation will maintain a higher PaO2 and SpO2 when compared with current standard use of facemask preoxygenation. Hence, we conducted a randomized comparative study to evaluate the comparative efficacy of preoxygenation with use of conventional facemask ventilation and THRIVE during RSI in patients undergoing general anaesthesia for emergency surgeries.

AIMS AND OBJECTIVES

PRIMARY OBJECTIVE:

To compare the partial pressure of arterial oxygen(PaO_2) at the end of successful endotracheal intubation between the two groups.

SECONDARY OBJECTVE:

To compare the lowest SpO_2 values achieved during intubation between the two groups.

REVIEW OF LITERATURE

Rapid sequence induction (RSI), a specialized method of intravenous (iv) induction of anaesthesia, is commonly employed for emergency surgeries where an increased risk of gastric regurgitation and pulmonary aspiration of gastric contents exists.[1]RSI consists of pre-oxygenation, administration of fixed doses of rapidly acting iv induction anaesthetics and neuromuscular blockers along with application of cricoid pressure which is followed by tracheal intubation without intermittent positive pressure ventilation.[19]

Cricoid pressure, eponymously referred to as Sellick manoeuvre after the physician who first described it, involves the application of pressure at the cricoid ring to occlude the upper oesophagus thereby preventing the regurgitation of gastric contents into the pharynx. The recommended force to be applied is 10 Newtons (N) while patient is awake, increased to 30 N after loss of consciousness.[19]

The goal of RSI is to achieve optimal intubating conditions rapidly to minimize length of time between the loss of consciousness and securing of the airway with a cuffed endotracheal tube. The term modified RSI is frequently used, but no standardized definition exists. A survey by anaesthesia residents and attending anaesthesiologists in USA showed that the term was most commonly used to refer to the use of gentle mask ventilation in conjugation with cricoid pressure.[19]

Since patients undergoing emergency surgeries are at a higher risk for developing hypoxia and aspiration of gastric contents during the procedure of intubation, an anaesthesiologist gets limited time for securing airway. RSI is the preferred method, and pre-oxygenation is mandatory for these critically ill patients as it not only de-nitrogenates the lungs but also prolongs the safe apnoea period during tracheal intubation. Pre-oxygenation increases the O_2 reservoir in the lungs to reduce intubation related oxy-haemoglobin desaturation.[3] Despite adequate conventional pre-oxygenation, these critically ill patients may experience episodes of significant desaturation.

Critically ill patients have a shorter safe apnoeic time due to

physiological stressors that accompany critical illnesses, such as decreased cardiac output, increased shunting, and reduced pulmonary reserves.[20] Oxygen saturation in these patients can rapidly drop to a critical hypoxic state of less than 70% within seconds.[21] Furthermore, with increasing prevalence of obesity both locally and worldwide, the safe apnoeic time is further shortened.[22] It is estimated that a moderately ill normal-sized adult would reach an oxygen saturation (SpO_2) of 90% at slightly within 5 minutes, while a 127-kg obese adult would reach such a level within 2.5 to 3 minutes.[23]

Prolongation of safe apnoea time and adequate pre-oxygenation would ameliorate some of these negative outcomes by preventing hypoxia and allowing more time to achieve successful intubation. The effectiveness of pre-oxygenation is assessed by its efficacy and efficiency. The increase in fraction of alveolar O_2 (FAO_2), decrease in the fraction of alveolar nitrogen (FAN_2), and increase in arterial oxygen tension (PaO_2) determines the efficacy of pre-oxygenation. Efficiency of pre-oxygenation is assessed from the decline of oxyhemoglobin desaturation (SaO_2) during apnoea (cessation of breathing or ventilation).[4] Efficacy and efficiency of pre-oxygenation is affected by factors like fraction of inspired oxygen (FiO2), duration of pre-oxygenation, and the alveolar ventilation/functional residual capacity ratio.[4] Oxygen insufflation after pre-oxygenation in the apnoeic period can prolong safe apnoea time.[24,25] In the apnoeic adult consumption of oxygen is 230ml/min and CO2 production is only 20ml/min , rest of the CO2 gets buffered within the body tissue. This creates pressure gradient between upper airway and alveoli which sucks in the oxygen if the airway remains patent thereby prolonging apnoea time.

Various techniques commonly used for pre-oxygenation with facemask include tidal volume breathing (TVB), deep breathing and positive airway pressure. The traditional method of TVB with 100% oxygen for 3 to 5 minutes technique for preoxygenation with fresh gas flows(FGF) ranging from 5 to 35 L/min have been successfully used for preoxygenation.[5] The other method which was used by Gold and colleagues is deep breathing in which patient is asked to take 4 deep

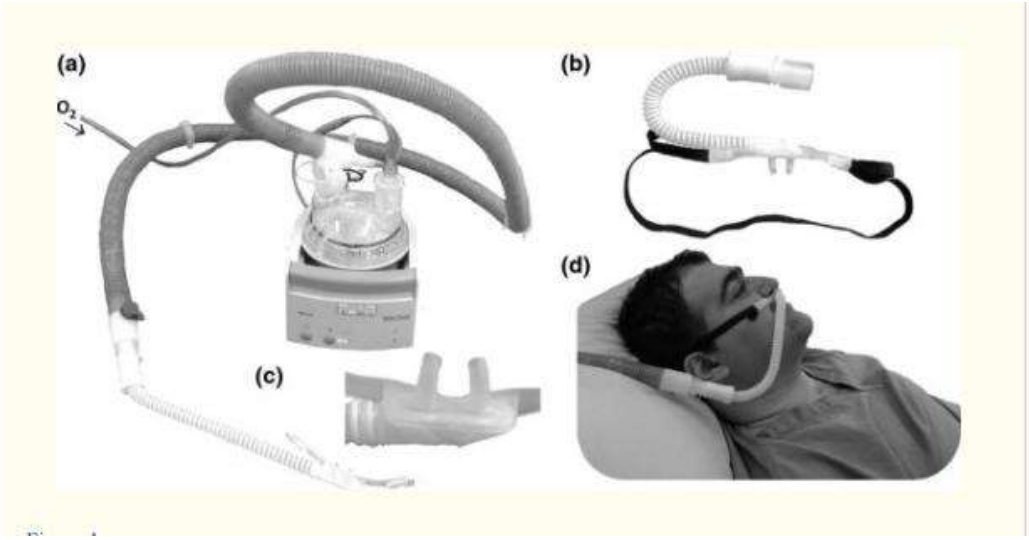
breaths in 30 seconds, based on the assumption that alveolar denitrogenation can be achieved rapidly by deep breathing.[6] However, this method was found to be inferior to tidal volume breathing due to rebreathing of exhaled nitrogen and a decreased FiO2.[7] Therefore, the duration of deep breathing was extended to 1, 1.5, and 2 minutes (to allow 8, 12, and 16 deep breaths, respectively) along with use of high FGF (≥10 L/min) to achieve maximal preoxygenation (evidenced by higher EtO2, PaO2, and lower EtN2) and to improve efficiency (evidenced by delay in onset of oxyhemoglobin desaturation during apnea.[8,9] A single vital capacity breath (SVCB) technique over 30 seconds used for preoxygenation, also resulted in a PaO2 comparable to that achieved by TVB for 3 minutes.[10]

Lately, the use of non-invasive positive-pressure ventilation (NIPPV) with positive end-expiratory pressure (PEEP) with 100% oxygen in the reverse Trendelenburg position has been recommended to maximize preoxygenation in obese and/or critically ill patients.[11,12] By increasing mean airway pressure, NIV with PEEP recruits alveoli that contribute to increased right-to-left shunt in vulnerable patient populations.[12] Current practice employs the use of tidal volume breathing with conventional facemask for preoxygenation for 3 minutes at flow rates of oxygen upto 15L/min. With maximal preoxygenation, the time to oxyhemoglobin desaturation below 80% can vary from 9 minutes in healthy non-obese adults to 3 minutes or less in children or obese adults.[13] Maximal flows which can be kept in the conventional facemask technique is limited only upto 15 litres because insufficient heating and humidification with this technique leads to poor tolerance and complaints especially of dry nose, dry throat and nasal pain.[14] The inspiratory flow of critically ill patients may vary widely from 30 L/min to more than 100 L/min. The difference between patient's inspiratory flow and delivered flow is large, and as a result, FiO_2 delivered is both inconstant and often lower than expected.[15]

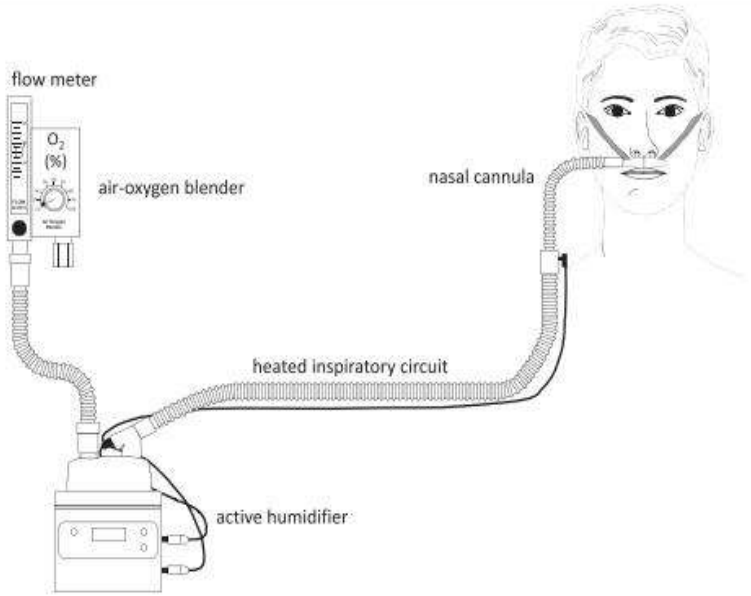
Thus, the current usual practice of pre-oxygenation using conventional facemask and nasal cannula for apnoeic oxygenation may not be adequate in maintaining oxygenation during RSI of critically ill

patients.[26]

THRIVE has been recommended as an alternative method for pre-oxygenation and apnoeic oxygenation during RSI .This is a device that offers high flows of totally humidified gases (37 degrees C,100% relative humidity, 44mmHg H_2O/L from 20L to 60L/min through specific cannula).



PICTURE 1: (a) oxygen humidification unit, (b) & (c) receives oxygen from a standard oxygen regulator and delivers humidified oxygen to a custom-built transnasal oxygen cannula (d) standard nasal oxygen cannula .[14]



PICTURE 2: Schematic presentation of High Flow Oxygen Device and its parts.[15]

A heated humidifier connected to a heated insulated single limb circuit provides active humidification.[15,27] It delivers heated and humidified oxygen with FiO_2 ranging from 21% to 100% and flows upto 60L/min through specially designed HFNC.[15] HFNC was first developed for use in neonates. Although many adult patients found the use of a close fitting mask not particularly tolerable, the most common issue in the adult population usually remained clearance of airway secretions.[28] HFNC was thus originally developed with the intention of maintaining the benefit of high oxygen flows (and thus the increased end-expiratory pulmonary pressures) without compromising blood flow to skin areas susceptible to pressure sores which is associated with the use of facemask.[29]

Over the last 10 years, HFNC has had widespread use in the adult population as it can provide non invasive ventilation with little discomfort to the patient.[30] However, there is still much debate regarding the role of the HFNC in the management of critically ill patients and only recently some better quality research has emerged on the topic.

Most of the benefits of HFNC are attributed to generation of modest levels of positive airway pressure. The high flow rates creates a positive airway pressure which linearly correlates with the administered flow rates.[31] The mean airway pressure increases by 0.69cm H_2O in the mouth closed position and 0.35 cm H_2O in the mouth open position for increase in every 10L/min of gas flow . The analysis of pressure generated during different parts of respiratory cycle showed that higher pressure is generated during expiration than inspiration, which is flow dependent. This mechanism resembles application of PEEP and it causes recruitment of atelectatic areas and thus increases the end expiratory lung volume by ~ 25%. Lung compliance increases and patient breathes more slowly with almost 10% higher tidal volumes and lower respiratory rates.[32,33,34] A study performed in human volunteers undergoing elective cardiac surgeries demonstrated that high flows delivered through HFNC generated positive airway pressures in the nasopharynx (<3 cmH_2O), which despite being relatively low compared

to those generated easily in closed systems, could prevent alveolar closure.[35] However, concern has been raised that this positive airway pressure may cause gastric insufflation, potentially increasing the risk of regurgitation and aspiration in an unprotected airway.

Elizabeth McLellan et al. conducted a prospective, interventional, assessor-blinded study to evaluate the effects of HFNC on gastric content and gastric distension in healthy fasting adult volunteers. Sixty healthy non pregnant adult patients were enrolled who were asked to fast from solids for 8 hours and clear liquids 2 hours. No subject was found to have air gastric distension either at baseline or after treatment with HFNO at 70L/min for 30 minutes. All subjects had either a Grade 0 or Grade 1 antrum, with similar distribution of antral grades and similar volume of gastric secretions before and after treatment with HFNO. However, the results could not be generalised to the subject under anaesthesia and patient with lower oesophageal sphincter incompetence and impaired gastric emptying.[36]Thus they concluded that HFNC does not cause gastric distension or increase in gastric secretions.

Theoretical benefits of THRIVE have led to attention of many towards its use of in various situations demanding longer safe apnoea time. Various studies have been conducted for comparative evaluation of the safety and efficacy of THRIVE with conventional facemask as pre-oxygenation method.

In 2015, A. Patel et al. found THRIVE to be beneficial in extension of apnoea time in 25 patients with difficult airway. There were 12 obese patients and nine patients were stridulous. Continuous delivery of transnasal high-flow humidified oxygen, initially to provide pre-oxygenation, and then continuing as post-oxygenation during intravenous induction of anaesthesia and neuromuscular blockade until a definitive airway was secured was performed. None of the patients developed cardiac arrhythmias or any other sign of carbon dioxide toxicity despite of an average apnoea time 17 minutes without any desaturation below 90%.[14]However Frumin et al reported that THRIVE can meet the oxygen demand of the patient but cannot stop the carbon

dioxide retention in the body thereby leading to its toxicity resulting in ventricular arrhythmias and acidosis.[31]

Various studies have found that THRIVE when used for pre-oxygenation, safely extended apnoea period in patients undergoing general anaesthesia for various surgeries. Mir et al compared the effect of pre-oxygenation with conventional facemask and THRIVE in 40 patients undergoing RSI for emergency surgery on arterial blood gas profile. Pregnant females and patients with severe cardiorespiratory disease were excluded. Patients in the THRIVE group were preoxygenated with high flow nasal cannula with flows at 30 L/min-70L/min until the placement of tracheal tube whereas patient assigned with the conventional facemask were preoxygenated for 3 minutes using a circle system with an oxygen rate of 12 L/minute. Thus they found no difference in the arterial blood gas profile ($PaO_2$and $PaCO_2$) between both groups inspite of longer apnoea time in THRIVE.[16]

In a study by Lyons C et al, adults patients undergoing general anaesthesia for non emergency surgeries were divided into three groups- facemask, high flow nasal oxygenation (HFNO) and HFNO with mouth piece. They compared the PaO_2 values after 3 minutes of preoxygenation among the three groups and did not found any significant difference between the three groups.[37]

Yasser et al studied efficacy of THRIVE with facemask preoxygenation in pregnant females where they applied oxygen flows of 6l/min and 30-50l/min in facemask and THRIVE respectively. They found significant increase in PaO2 values between the two groups after 3 minute of apnoea period. Therefore they concluded THRIVE to be safe, effective and superior to facemask in oxygenation and extending safe apnoea period in pregnant females unlike previous studies in different sets of population.[38]

In 2017, Santi Maurizio Ranieri evaluated the efficacy and safety of using HFNC in 45 patients undergoing RSI. HFNO at an inspiratory oxygen fraction of 1 at 60L/min was applied for 4 min before laryngoscopy and maintained until the patient was intubated, and correct intubation was verified by the appearance of the end-tidal

CO_2($EtCO_2$) waveform. Primary outcome was SpO_2 and its modification at four time points(T0-T3)-baseline, 4 minutes on HFNO ,at laryngoscopy and endotracheal intubation .None of the patient desaturated <3% from baseline at any four point of time. So, they concluded HFNO as an effective and safe technique for pre-oxygenation in patients undergoing RSI for emergency surgeries.[39]

Sjoblom et al also compared the efficacy of pre-oxygenation with 100% oxygen using THRIVE and facemask in 350 adult patients undergoing rapid sequence induction in emergency surgery. Patients were preoxygenated with oxygen flows of 30-70l/min in THRIVE group and 10l/min in facemask. They observed no significant difference seen in lowest median SpO_2 values between both the groups. Their results concluded that high-flow nasal oxygen maintains adequate oxygen levels during pre-oxygenation for rapid sequence induction.[40]

In a randomized non blinded clinical trial, Lodenius et al also compared the lowest peripheral O_2 saturation during intubation in 80 adult patients when preoxygenated either with conventional facemask or THRIVE requiring RSI for emergency surgery. They found desaturation below 93% in 5 patients when pre-oxygenated with facemask versus none with THRIVE.[17]

Rajan S et al in 2018 also compared time to desaturate below 90% during apnoea with THRIVE versus traditional preoxygenation followed by apnoeic oxygenation. This prospective, randomized, single-blinded study was conducted in 10 adult ASA physical status I and II patients presenting for direct laryngoscopy under general anaesthesia without endotracheal intubation. Group P patients were preoxygenated with 100% oxygen with snuggly fitting facemask at 6 L/min, and in Group H, high-flow humidified oxygen was delivered using nasal cannula at 60l/min for 3 minutes. Group H had a significantly longer apnoea time as compared to Group P. All patients in Group H continued to have nearly 100% saturation even at 12 min of apnoea. However, in Group P 80% of patients desaturated to <90% after 6 minutes of apnoea.[41] Therefore incidence of desaturation could be lowered in patients when pre-oxygenated with THRIVE.

In 2021, Zhen hua et al conducted a randomised controlled study to assess the prolongation of apnoea time with conventional facemask and THRIVE pre-oxygenation in 60 elderly (65yr-80yr) ASA grade I-III patients requiring tracheal intubation or the application of laryngeal mask under general anaesthesia. Patients were pre-oxygenated for 5 minutes using the high flow nasal cannula at flow rate of 30-70L/min in the THRIVE group and using a facemask at a flow rate of 100% oxygen at 10 L/min without positive airway pressure in the facemask group. The apnoea time was found to be prolonged in the THRIVE group ($p<0.01$). No significant differences were found in PaO2, PaCO2 and vital parameters between the two groups.(18) Thus this study also supports the extension of apnoea time when preoxygenation is done with THRIVE.

Jian-li Song et al reviewed 14 RCTs (including 1012 participants) done on effectiveness of HFNO versus standard facemask ventilation (FMV) in pre and apnoeic oxygenation. This meta- analysis evaluated six indicators which were arterial oxygen partial pressure (PaO2), end expiratory oxygen concentration (EtO2), safe apnoea time, minimum pulse oxygen saturation (SpO2min), oxygenation (O2) desaturation and end expiratory carbon dioxide (EtCO2) or Arterial carbon dioxide partial pressure (PaCO2). Meta-analysis based on 8 studies showed PaO2 to be significantly higher in HFNO group than FMV but subanalysis of 7 RCTs showed no significant difference of PaO_2 between two groups whereas significantly longer safe apnoea time was found in HFNO group. There was no significant statistical difference found in the minimum SpO2, CO2 accumulation, EtO2 and O2 desaturation rate during anaesthesia induction between the two groups.[42]

Thus based on the conclusion from above mentioned studies, we proposed that the use of THRIVE at 60L/min for pre-oxygenation and apnoeic oxygenation will maintain a higher PaO_2 and SpO_2 when compared with current standard use of facemask pre-oxygenation. Hence, we designed a randomized comparative study to evaluate the efficacy of pre-oxygenation with both conventional facemask ventilation

and THRIVE during RSI in patients undergoing emergency surgery under general anaesthesia.

MATERIALS AND METHODS

SOURCE OF DATA

A randomized controlled study was conducted in the department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana after approval by the Institutional Ethics Committee on 80 adult patients undergoing emergency abdomino-pelvic surgeries under general anaesthesia during the time period from May 2021 to August 2022. These patients were randomly allocated to either of the two study groups by computer generated random numbers contained in sealed, sequentially numbered envelopes. A written informed consent was obtained from each patient.

METHOD OF COLLECTION OF DATA

Inclusion criteria:

- Patients who required rapid sequence induction (RSI) during general anaesthesia for urgent/emergent abdomino-pelvic surgeries.
- Patients aged 18 years and above, who are competent to give informed consent.

Exclusion criteria

- Pregnant females at any gestational age.
- Patients with severe cardio-respiratory disease.
- Clinical suspicion or confirmed diagnosis of base of skull fracture or severe facial trauma that precludes nasal cannula placement.
- Contraindications to the rapid sequence induction, if any (e.g. already intubated patients)**.**
- BMI ≥40kg/m^2
- Patients with laryngotracheal stenosis or benign or malignant hypopharyngeal obstruction.

GROUP ALLOCATION

Patients undergoing RSI under general anaesthesia for emergency abdomino-pelvic surgery during the time period from May2021 to August 2022 were recruited for the study and an equal number of patients were allocated randomly using computer generated random number list to either of the following two groups.

GROUP T (THRIVE group): Patients were preoxygenated for three minutes with heated and humidified 100% oxygen via a high flow nasal cannula at flow of 60L/min using Transnasal Humidified Rapid-insufflation Ventilatory Exchange (THRIVE) and this flow was maintained until successful placement of the tracheal tube.

GROUP F (Facemask group): Patients were preoxygenated for three minutes with 100% oxygen via a tightly held snuggly fitting facemask at flow of 12 L/min using a circle system and this flow was maintained until laryngoscopy was attempted.

PRE-ANAESTHETIC CHECKUP

Routine thorough check-up was conducted comprising of detailed history, comorbidities, allergy to any drug being used, general physical and systemic examination. Patients were explained about the study being conducted and written informed consent was taken. Demographic information and preoperative variables including age, gender, BMI, ASA physical status, Modified Mallampati grade, indication for surgery, preoperative Arterial Blood Gas (ABG) values and Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM) were recorded.

ANAESTHESIA TECHNIQUE

On arrival in the operating room, the patients were positioned on the operating table in the supine position and routine monitoring in the form of 5-lead electrocardiography, non-invasive blood pressure (NIBP) using an automated non-invasive device and pulse oximetry was instituted. Continuous monitoring of heart rate (HR), blood pressure (cycled to 1 minute interval) and SpO_2 was done and mean of three consecutive readings at one minute interval was recorded as baseline. An arterial catheter was then placed in the radial artery under local infiltration anaesthesia. An arterial ABG sample if clinically indicated was sent.

Patients were preoxygenated with 100% oxygen for 3 minutes using the method randomly allocated to him/her. Patients in group T were preoxygenated with heated and humidified 100% oxygen delivered via a high flow nasal cannula at an oxygen flow of 60 L/min using THRIVE

while in group F patients were preoxygenated with 100% oxygen via a tightly held well fitting facemask at an oxygen flow of 12 L/min using a circle system. Patients in both the groups were maintained on jaw thrust to ensure airway patency throughout the period of apnea. If nasogastric tube was in situ then it was attached to continuous low grade suction to decompress the stomach.

RSI was accomplished using intravenous (IV) etomidate (0.2 to 0.4 mg/kg) or propofol (1.5 to 3.5mg/kg) and fentanyl (2µ/kg) followed by administration of neuromuscular blocker (rocuronium 1mg/kg or succinylcholine 1.5 mg/kg as per patient profile). Cricoid pressure (starting from 10N to a maximum of 40 N) was applied as the patient becomes drowsy by a trained assistant.

In group T oxygen flow was kept at 60 L/min. Group F patients continued to receive oxygen flow at 12L/min through face mask, and bag and mask ventilation was not be performed. One minute after the administration of the neuromuscular blocker, laryngoscopy was performed by an experienced anaesthesiologist and airway was secured by an appropriate size endotracheal tube. After confirming successful tracheal intubation by well-formed four capnography waveforms on monitor, an ABG sample from the arterial catheter in situ was sent. Continuous monitoring of heart rate (HR), blood pressure (cycled to 1 minute interval), $EtCO_2$ and SpO_2 with waveform tracing were recorded at one minute interval at all times after recording baseline value, until five minutes after intubation.

Gentle intermittent positive pressure ventilation limiting the inflation pressure to 15cm H_2O using bag mask ventilation was instituted as a rescue in an event of desaturation to SpO_2< 90% during RSI. If bag mask ventilation was ineffective, an appropriate sized second generation Laryngeal mask airway (LMA) was inserted to rescue desaturation. Laryngoscopy and endotracheal intubation was commenced after SpO_2 ≥98% in the above eventually.

FOLLOWING OBSERVATIONS WILL BE RECORDED:

PRIMARY OUTCOME:

Partial pressure of arterial oxygen (PaO_2): PaO_2 was measured from the arterial blood gas sample obtained immediately after successful endotracheal intubation.

SECONDARY OUTCOMES:

1. Lowest SpO_2: SpO_2 was monitored and recorded at one-minute interval throughout the study period. The lowest SpO_2 measured from the measurement of baseline SpO_2 value until 5 minutes after endotracheal intubation was recorded.

2. Apnoea time: Apnoea time was recorded. It was defined as the period from the start of apnoea assessed visually in the THRIVE group and when the capnography trace disappeared in the facemask group till the appearance of well-formed waveform capnogram immediately after tracheal intubation. If a drop in SpO_2 to $\leq$ 90% occurred during the study period necessitating manual ventilation, this was recorded as the end of apnoea.

3. Number of attempts at laryngoscopy was recorded. Each attempt was defined as the passage of laryngoscope through the mouth**.**

4. Use of any rescue manoeuvres including bag and mask ventilation or use of second-generation laryngeal mask airway for ventilation was recorded.

5. Adverse events like drop in SpO_2 ($\leq$90%), haemodynamic instability like drop in MAP <20% from baseline and use of vasopressors if any was recorded.

6. P- POSSUM was calculated using an online calculator.

Statistical analysis:

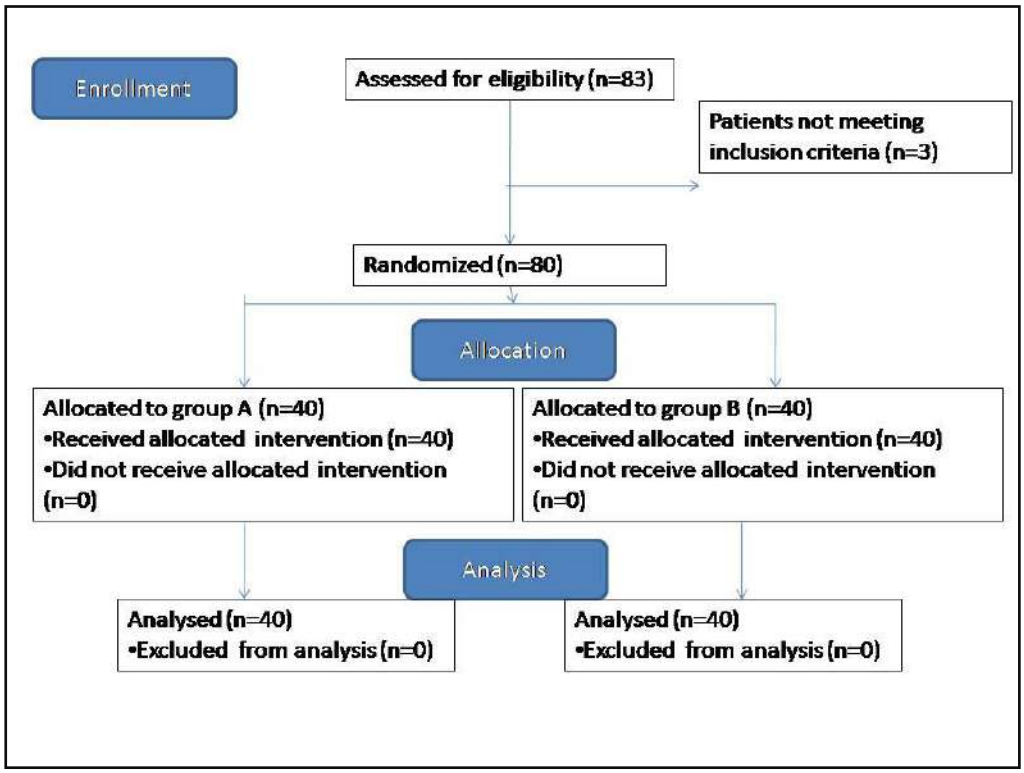
Data were described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. To determine whether the data were normally distributed, a Kolmogorov-Smirnov test was used. Comparison of quantitative variables between the study groups was done using Student t-test and MannWhitney U test for independent

samples for parametric and non-parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test was performed and fisher exact test was used when the expected frequency is less than 5. Covariates obtaining a P value <0.05 in the univariate analyses were included in the multivariate Binary logistic regression analyses. A probability value (p value)less than 0.05 was considered statistically significant. All statistical calculations were done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Window.

OBSERVATION AND RESULTS

This randomized controlled trial was conducted on 80 patients from May 2021 to August 2022 .Patients were divided into two groups - Group F (Facemask) and Group T (THRIVE).

FIGURE1: CONSORT Flow diagram of the study.



A total of 83 patients were enrolled for the study and 3 out of total patients were excluded as they were not meeting the inclusion criteria. Eighty patients were randomly allocated to either of the group by computer generated random number. They were analysed using SPSS 21 version statistical program for Microsoft Windows.

Demographic data was similar in both the groups

TABLE 1: COMPARISON OF STUDY GROUPS ACCORDING TO AGE.

	Group F		Group T		T	p-value
	Mean	SD	Mean	SD		
Age (years)	50.00	15.68	51.85	16.23	-0.518	0.606

The mean age of patients pre-oxygenated with facemask was 50±15.68 years and 51.85±16.23 years in THRIVE group. There was no statistical difference in the age distribution among two groups (p>0.05)

FIGURE 2: COMPARISON OF STUDY GROUPS ACCORDING TO AGE.

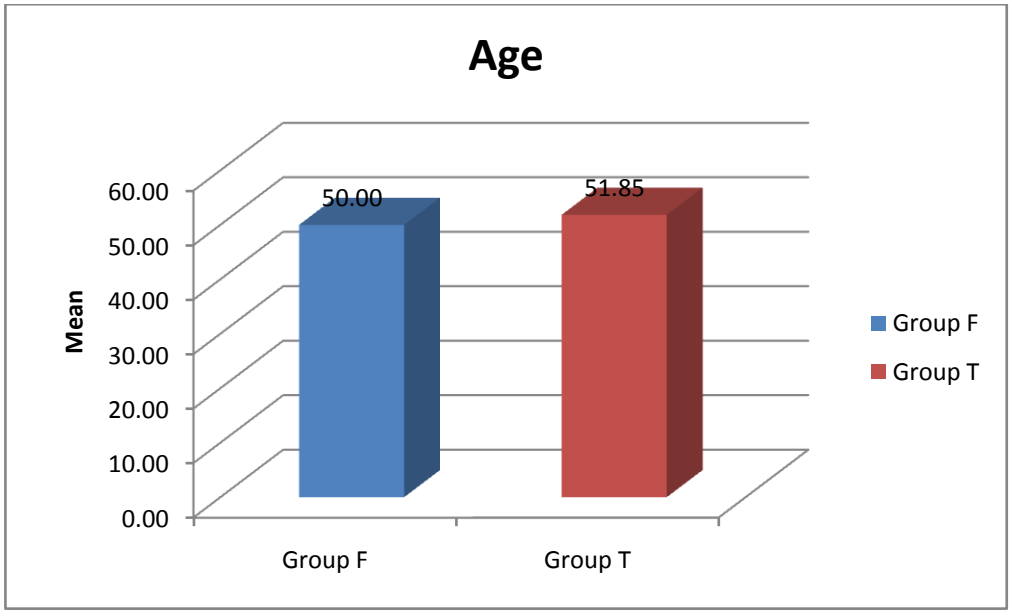


TABLE 2: COMPARISON OF STUDY GROUPS ACCORDING TO GENDER DISTRIBUTION.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%	No. of cases	%			
Gender	F	18	45.0%	15	37.5%	33	0.464	0.496
	M	22	55.0%	25	62.5%	47		
Total		40	100.0%	40	100.0%	80		

Group F comprised of 45% females and 55% males, while group T had 37% females and 62.5% males. Difference was statistically insignificant (p >0.05) between both the groups.

FIGURE 3: COMPARISON OF STUDY GROUPS ACCORDING TO GENDER DISTRIBUTION.

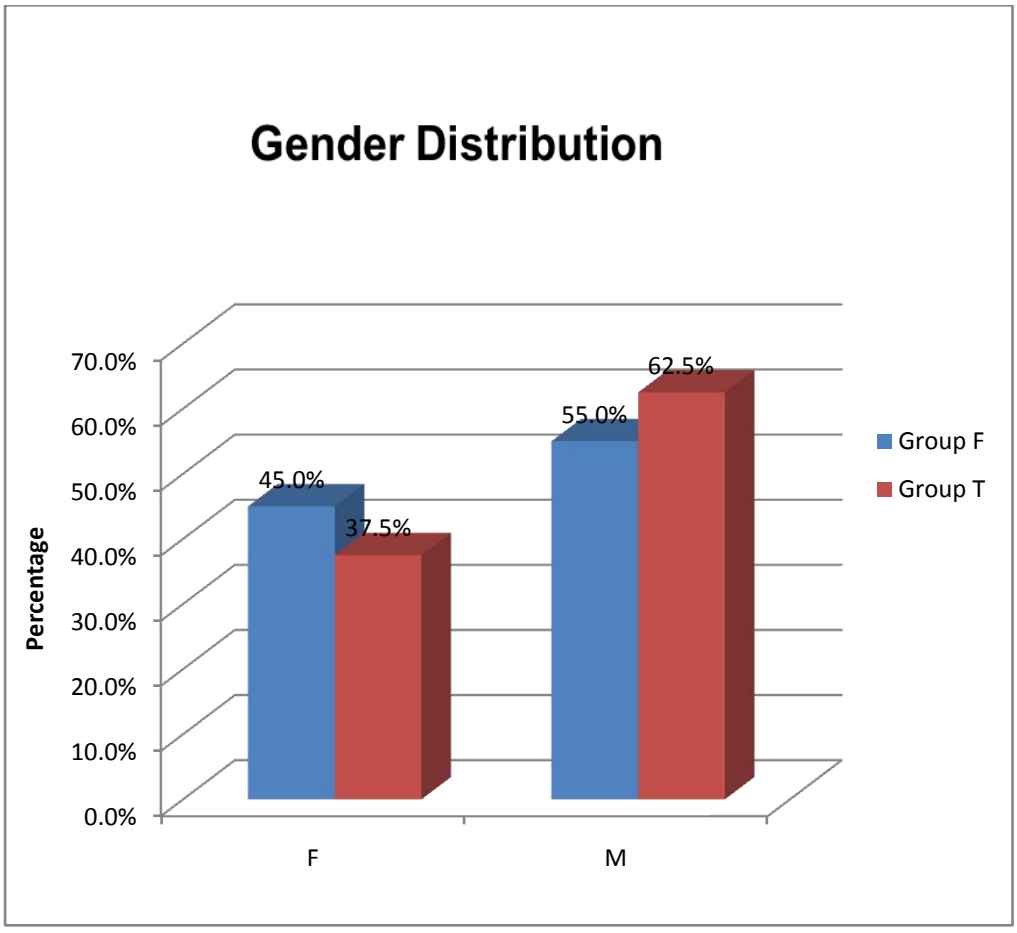


TABLE 3: COMPARISON OF STUDY GROUPS ACCORDING TO BASAL METABOLIC INDEX (BMI).

	Group F		Group T		Z	p-value
	Mean	SD	Mean	SD		
BMI (kg/m^2)	25.96	5.41	25.53	4.89	0.369	0.713

There was no statistically significant difference (p>0.05) of mean BMI distribution among patients in both the groups (p value of 0.713) .The mean BMI of patients who received oxygen via facemask was 25.96±5.41 kg/m^2 and 25.53±4.89 kg/m^2 in THRIVE group .

FIGURE 4: COMPARISON OF STUDY GROUPS ACCORDING TO BASAL METABOLIC INDEX (BMI).

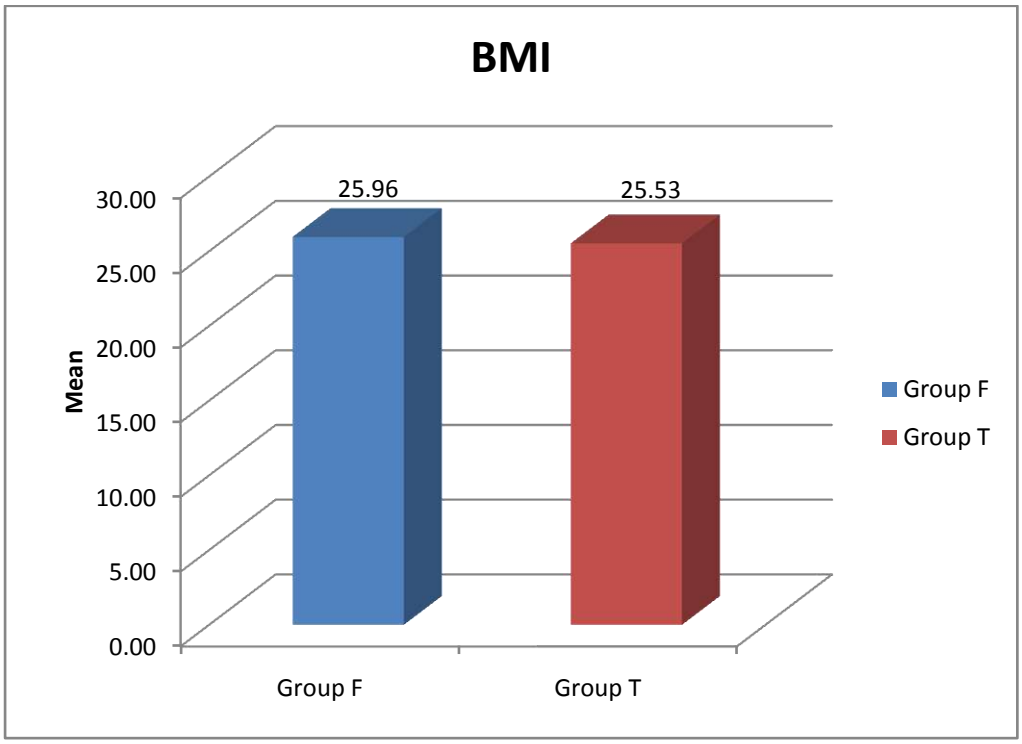


TABLE 4: COMPARISON OF STUDY GROUPS ACCORDING TO ASA GRADE.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%	No. of cases	%			
ASA grade	II	5	12.5%	2	5.0%	7	3.603	0.165
	III	19	47.5%	27	67.5%	46		
	IV	16	40.0%	11	27.5%	27		
Total		40	100.0%	40	100.0%	80		

In group F 12.5%, 47.5% and 40.0% of patients were ASA II, III and IV respectively whereas in group T 5%, 67.5% and 27.5% of patients were ASA II, III and IV respectively. Both of the groups were comparable in view of ASA grading and there was no statistically significant difference (p >0.05) between both the groups.

FIGURE 5: COMPARISON OF STUDY GROUPS ACCORDING TO ASA GRADE.

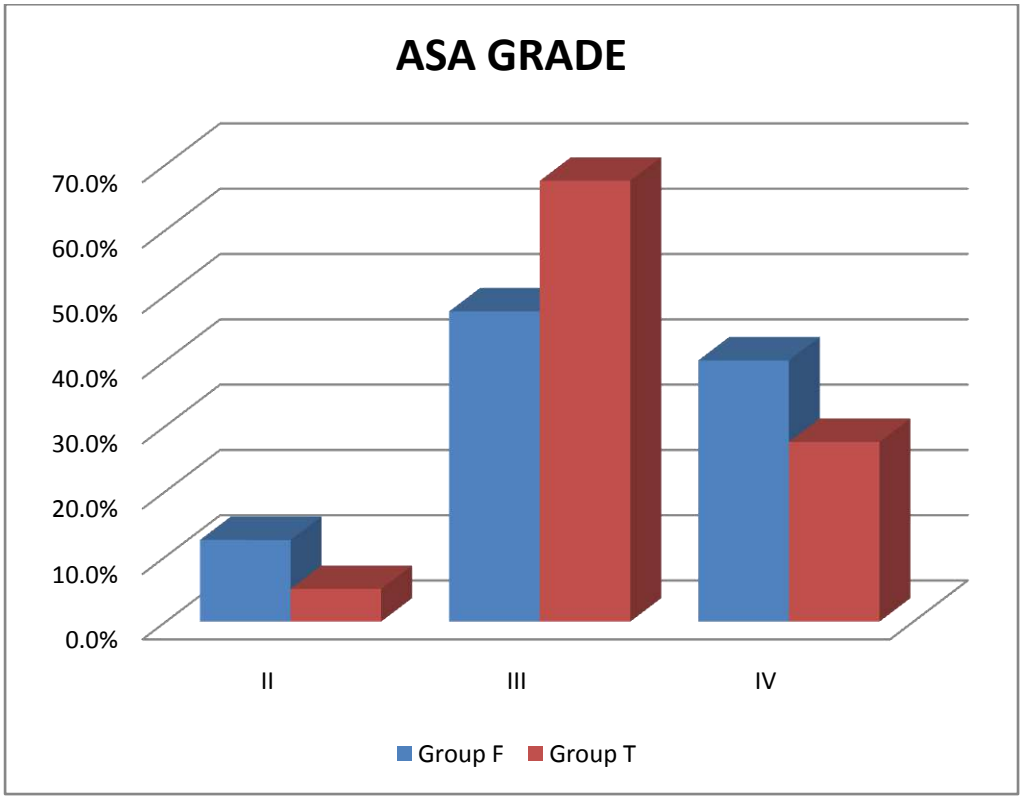


TABLE 5: COMPARISON OF STUDY GROUPS ACCORDING TO MODIFIED MALLAMPATI SCORE AND NECK CIRCUMFERENCE.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%	No. of cases	%			
Modified Mallampati Score	I	3	7.5%	1	2.5%	4	5.611	0.132
	II	12	30.0%	19	47.5%	31		
	III	16	40.0%	17	42.5%	33		
	IV	9	22.5%	3	7.5%	12		
Neck circumference (cm)	> 40	1	2.5%	2	5.0%	3	0.346	0.556
	< 40	39	97.5%	38	95.0%	77		

Modified Mallampati Score and Neck circumference were comparable in both the groups(p>0.05)

FIGURE 6a: COMPARISON OF STUDY GROUPS ACCORDING TO MODIFIED MALLAMPATI SCORE.

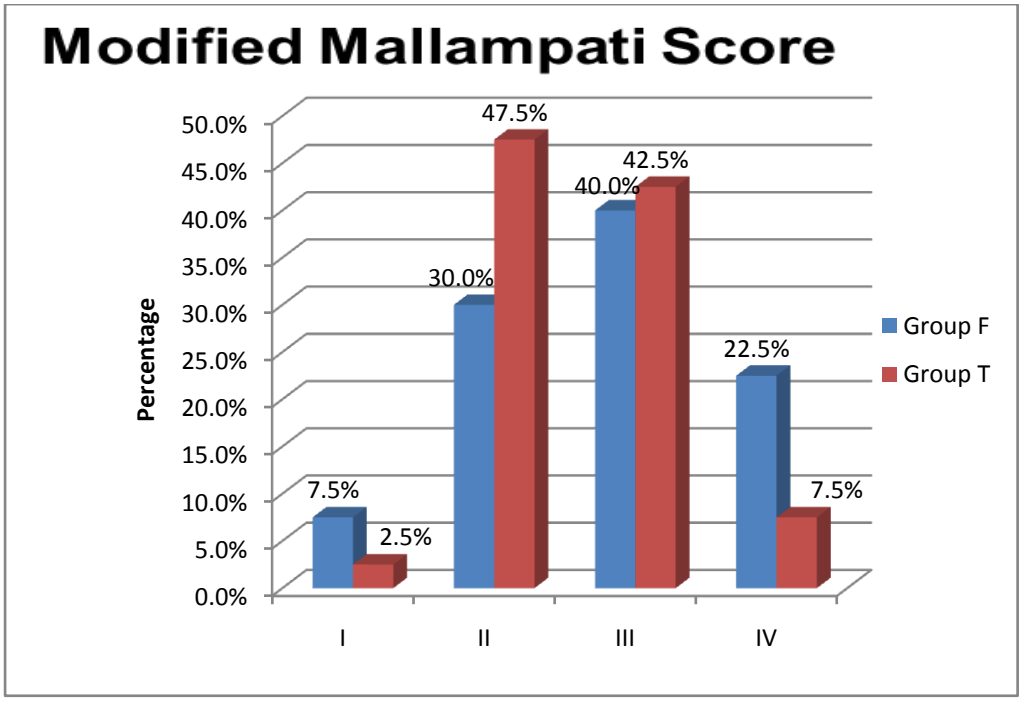


FIGURE 6b: COMPARISON OF STUDY GROUPS ACCORDING TO MODIFIED NECK CIRCUMFERENCE.

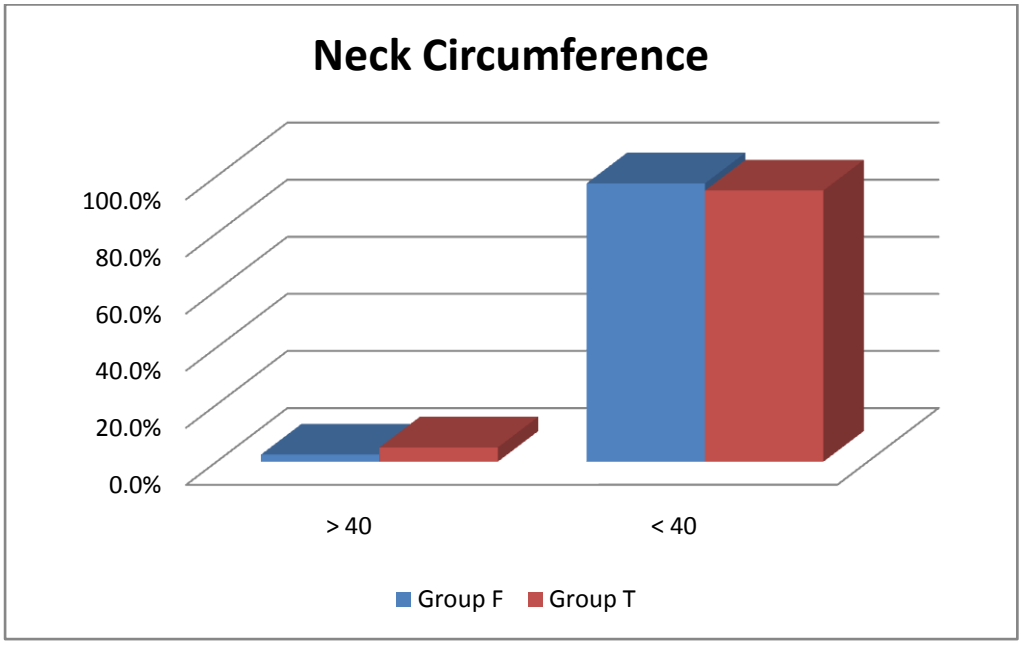


TABLE 6: COMPARISON OF STUDY GROUPS ACCORDING TO CORMACK LEHANE'S GRADE.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%	No. of cases	%			
Cormack Lehane's Grade	I	7	17.5%	3	7.5%	10	5.120	0.077
	II	27	67.5%	23	57.5%	50		
	III	6	15.0%	14	35.0%	20		
Total		40	100.0%	40	100.0%	80		

Cormack Lehane's Grade was I ,II and III in 17.5% ,67.5% and 15% patients respectively in facemask group and 7.5%, 57.5% and 35.5% respectively in THRIVE group .Difference between two groups was not statistically significant (p >0.05%.) in view of Cormack Lehane's grading.

FIGURE 7: COMPARISON OF STUDY GROUPS ACCORDING TO CORMACK LEHANE'S GRADE.

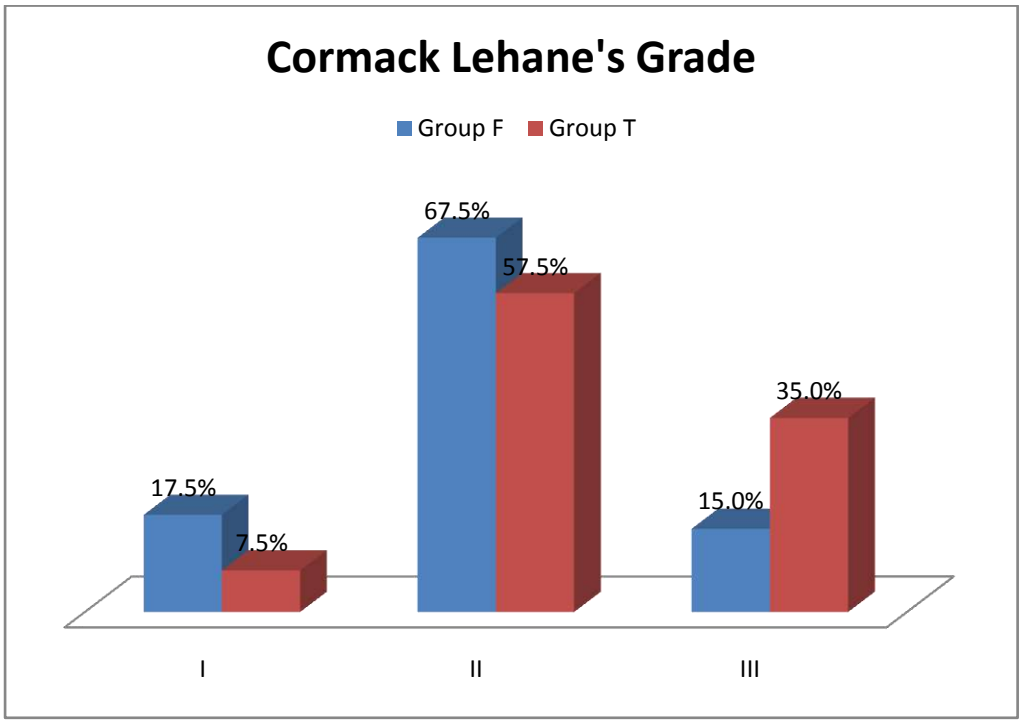


TABLE 7: COMPARISON OF BLOOD GAS ANALYSIS OF PATIENTS BETWEEN BOTH THE GROUPS AFTER INTUBATION.

	Group F		Group T		Z	p-value
	Mean	SD	Mean	SD		
PaO2(mmHg)	239.35	107.07	258.08	105.77	-0.787	0.434
PaCO2(mmHg)	44.75	6.50	43.81	10.35	0.488	0.627
pH	7.34	0.08	7.35	0.08	-0.233	0.817
HCO3(mmol/l)	24.73	3.92	25.22	4.71	-0.503	0.616
Lactates(mmol/l)	1.20	0.80	1.42	0.91	-1.161	0.249

Mean PaO_2 (primary outcome) was 239±107.07 mmHg in group F and 258±105.77mmHgin group T. Thus, there was no statistically significant difference in mean PaO_2between both the groups ($p>0.05$).
$PaCO_2$, pH, HCO3 and lactates in group F was 44.75±6.50 mmHg, 7.34±0.08,24.73±3.92mmol/l and 1.20±0.80mmol/l respectively whereas 43.81±10.35 mmHg, 7.35 ±0.08, 25.22±4.71mmol/l and 1.42±0.91mmol/l respectively in group T which was statistically insignificant.

FIGURE 8: COMPARISON OF BLOOD GAS ANALYSIS OF PATIENTS BETWEEN BOTH THE GROUPS AFTER INTUBATION.

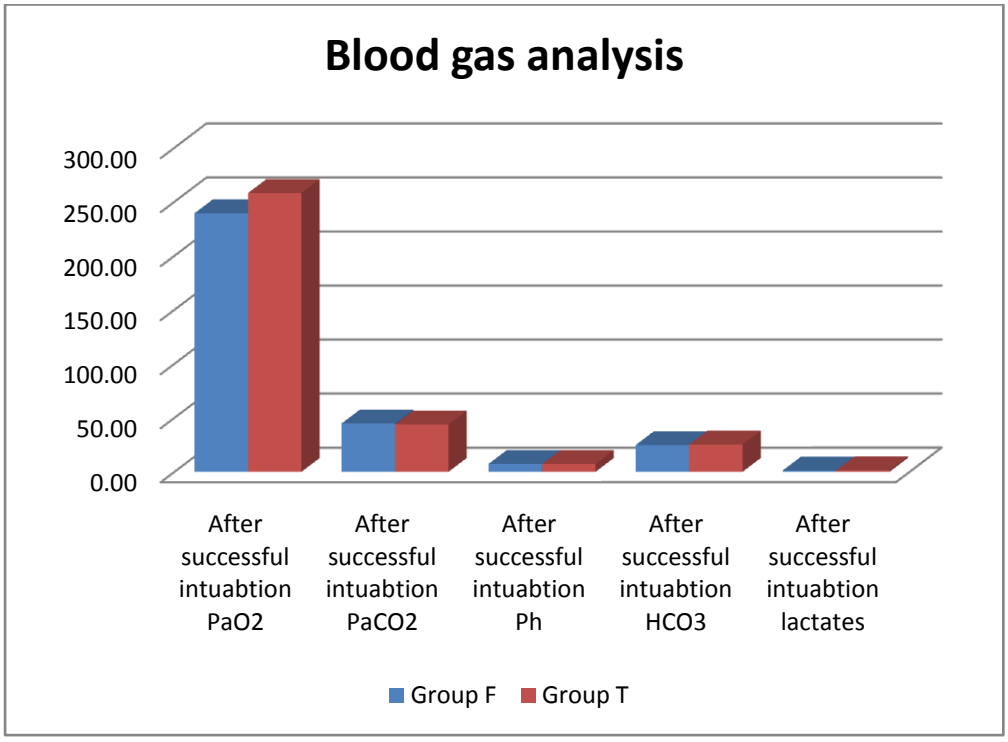


TABLE 8: COMPARISON OF LOWEST MEDIAN SPO_2 IN BOTH THE GROUPS.

	Group F		Group T		Z	p-value
	Median	IQR	Median	IQR		
Minimum Spo2 observed SECONDS	97.5	93.25-99	97	94-99	0.702	0.485

Lowest median SPO_2 was found to be 97.5% in the facemask group and 97% in the THRIVE group which was statistically insignificant.

FIGURE 9: COMPARISON OF LOWEST MEDIAN SPO_2 IN BOTH THE GROUPS.

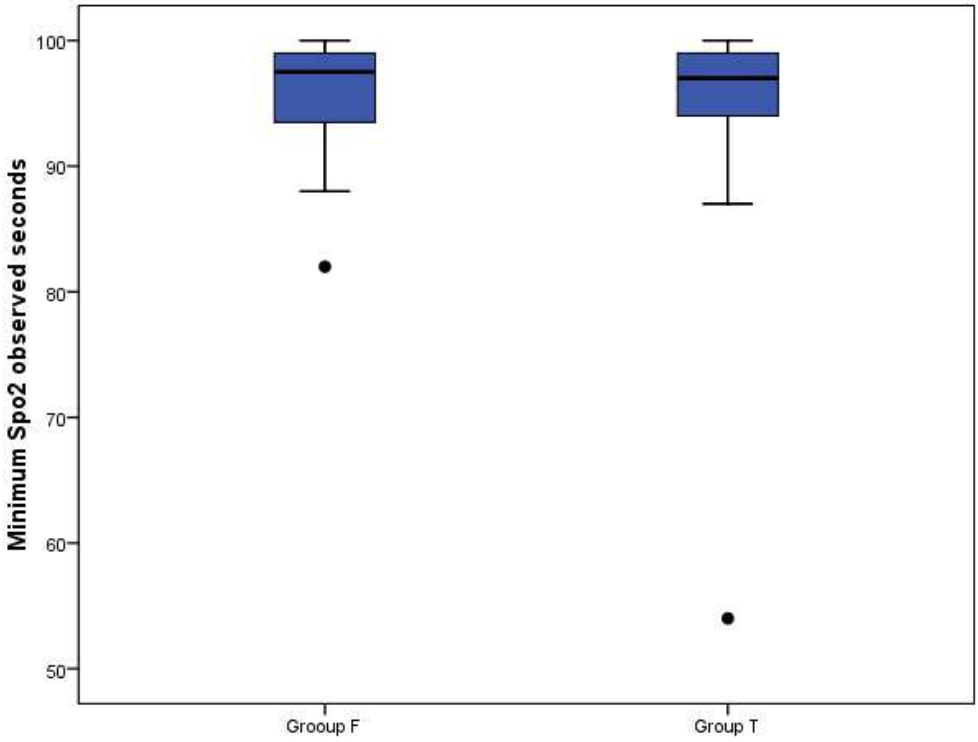


TABLE 9: COMPARISON OF APNOEA TIME OBSERVED BETWEEN TWO GROUPS.

	Group F		Group T		Z	p-value
	Median	IQR	Median	IQR		
Apnoea time(seconds)	88.5	74.25-113.75	100	80-120	-1.398	0.166

Apnoea time was taken as the period from the start of apnoea assessed visually in the THRIVE group and disappearance of waveform of capnogramin the facemask group till the appearance of well-formed waveform of capnogram immediately after tracheal intubation. Median apnoea time was found to be 88.5seconds and 100 seconds in facemask and THRIVE group respectively. No statistically significant difference was found between two groups p >0.05.

FIGURE 10: COMPARISON OF APNOEA TIME OBSERVED BETWEEN TWO GROUPS.

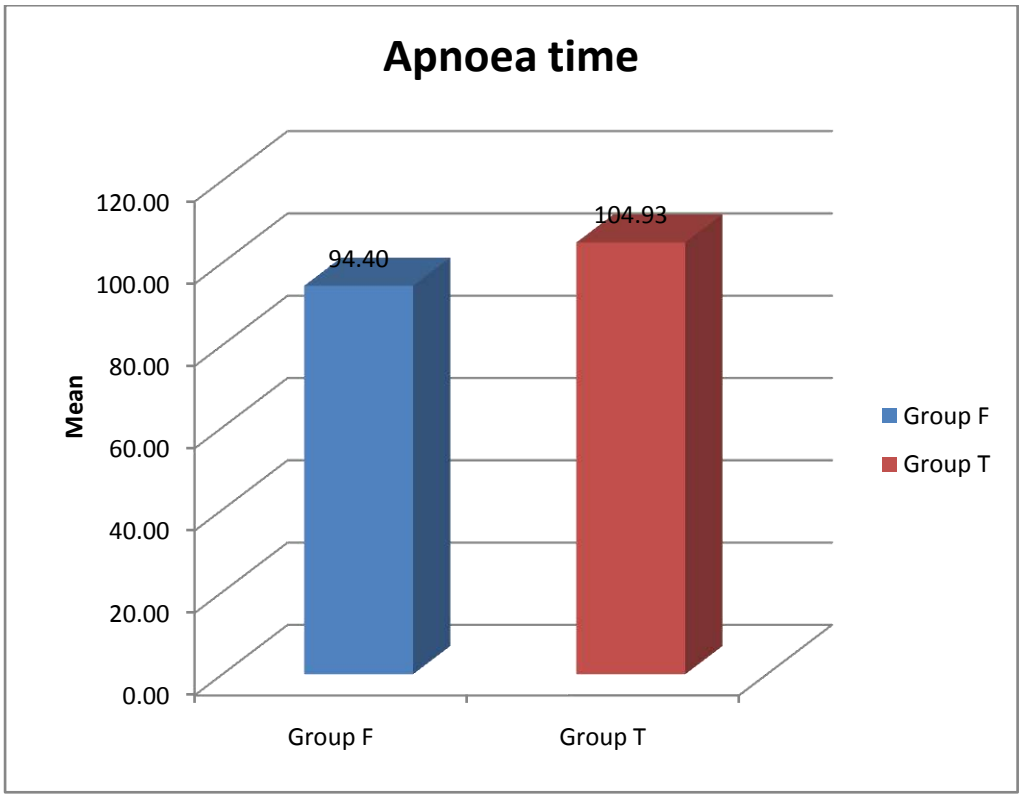


TABLE 10: COMPARISON OFATTEMPTS OF LARYNGOSCOPY OBSERVED BETWEEN TWO GROUPS.

	Group F		Group T		Z	p-value
	Median	IQR	Median	IQR		
Attempts of laryngoscopy	1	1-1	1	1-1	-0.350	0.728

No statistically significant difference was found between the two groups in view of attempts of laryngoscopy.

FIGURE 11: COMPARISON OFATTEMPTS OF LARYNGOSCOPY OBSERVED BETWEEN TWO GROUPS.

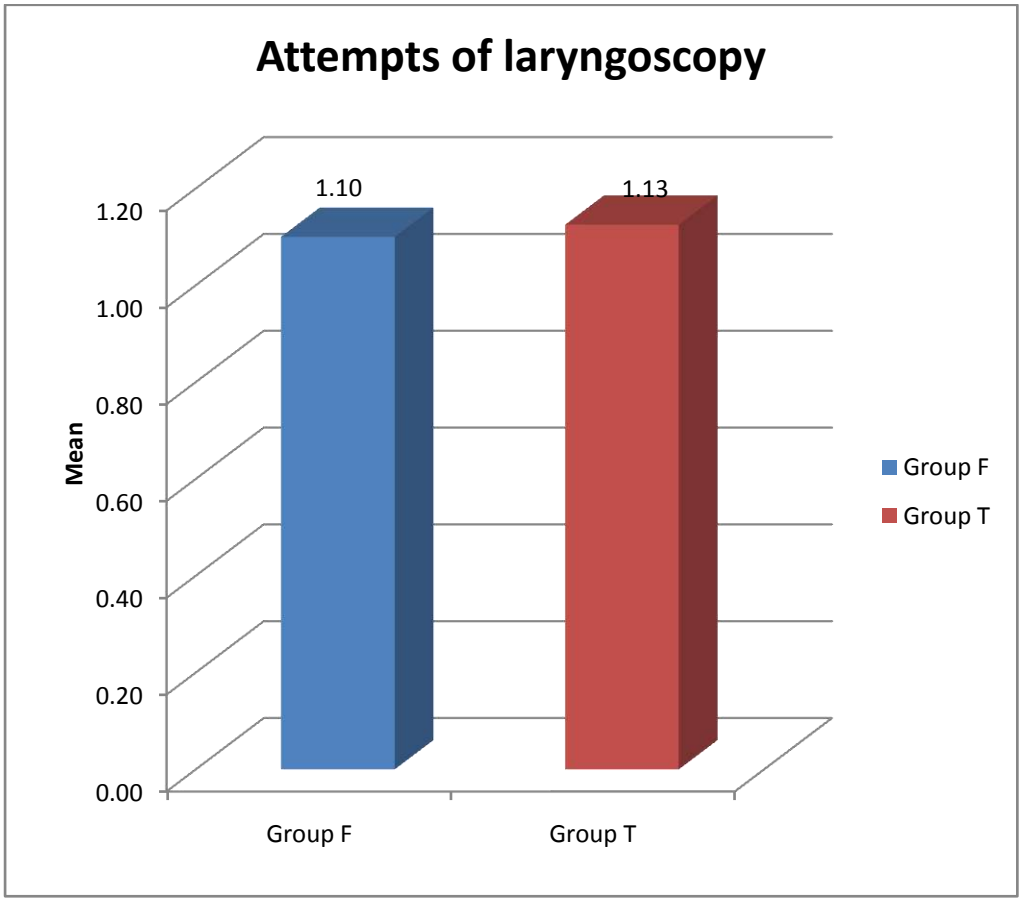


TABLE 11: NEED OF RESCUE MANOEUVRE BETWEEN THE TWO GROUPS.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%age	No. of cases	%age			
LMA	NO	40	100.0%	40	100.0%	80		
Bag and mask	NO	40	100.0%	39	97.5%	79	1.013	0.314
	yes	0	0.0%	1	2.5%	1		

Bag mask ventilation and insertion of LMA were used as manoeuvres to rescue desaturation. None of the patient in either group needed LMA where as only one patient desaturated below 90% in THRIVE where bag mask ventilation was used as rescue manoeuvre. Therefore difference between two groups was statistically insignificant (p>0.05)

FIGURE 12: NEED OF RESCUE MANOEUVRE BETWEEN THE TWO GROUPS.

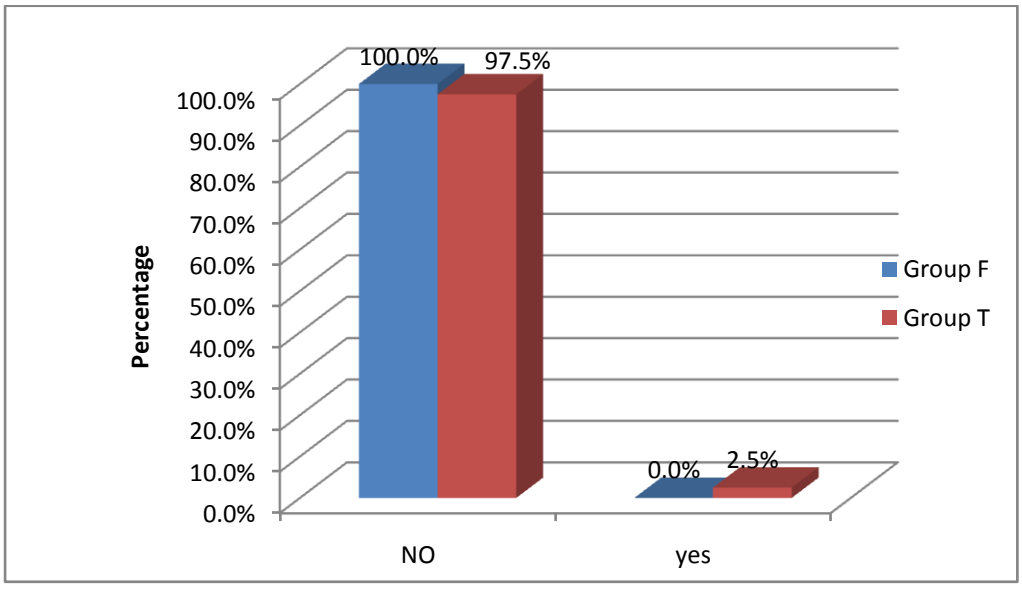


TABLE 12: COMPARISON OF ANY ADVERSE EVENT LIKE DESATURATION BELOW 90% AND USE OF VASOPRESSOR BETWEEN BOTH THE GROUPS.

		Group F		Group T		Total	Chi-square value	p-value
		No. of cases	%age	No. of cases	%age			
SPO2 less than 90%	NIL	40	100.0%	39	97.5%	79	1.013	0.314
	YES	0	0.0%	1	2.5%	1		
Total amount of vasopressor used ml/hr(80mcg/ml)	10	0	0.0%	1	2.5%	1	2.000	0.368
	5	1	2.5%	0	0.0%	1		
	Nil	39	97.5%	39	97.5%	78		

None of the patient desaturated below 90% in facemask group whereas only one patient desaturated below 90% in THRIVE .Thus no statistically significant difference was found between the two groups ($p > 0.05$).

In both the groups, one patient in either group required infusion of nor-epinephrine due to hypotension.

FIGURE 13a: COMPARISON OF DESATURATION BELOW 90% BETWEEN BOTH THE GROUPS.

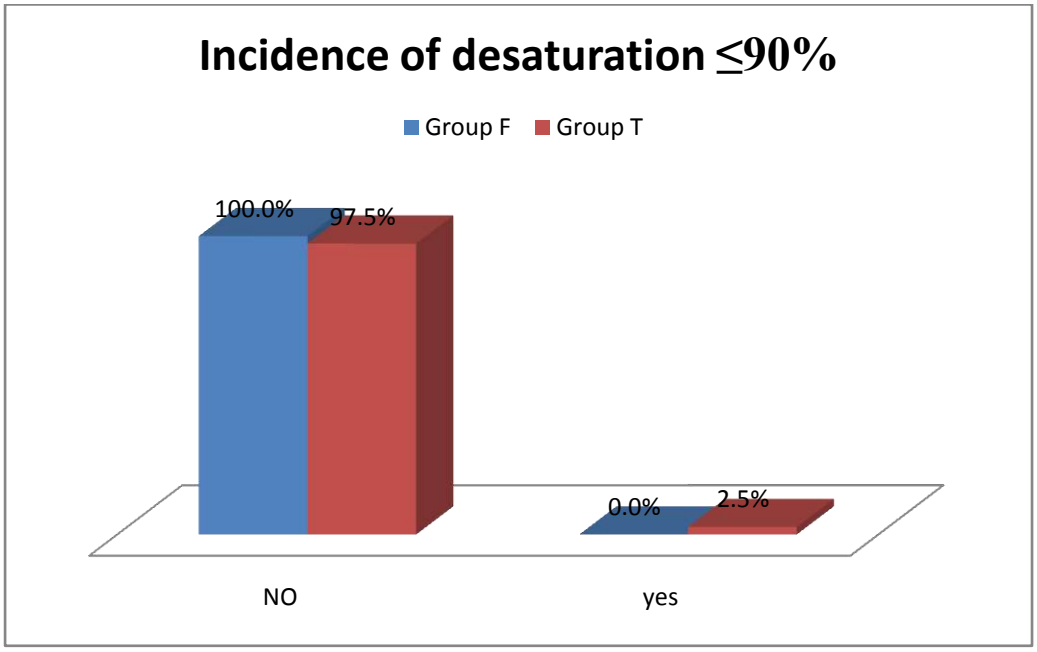


FIGURE 13b: COMPARISON OF USE OF VASOPRESSOR BETWEEN BOTH THE GROUPS.

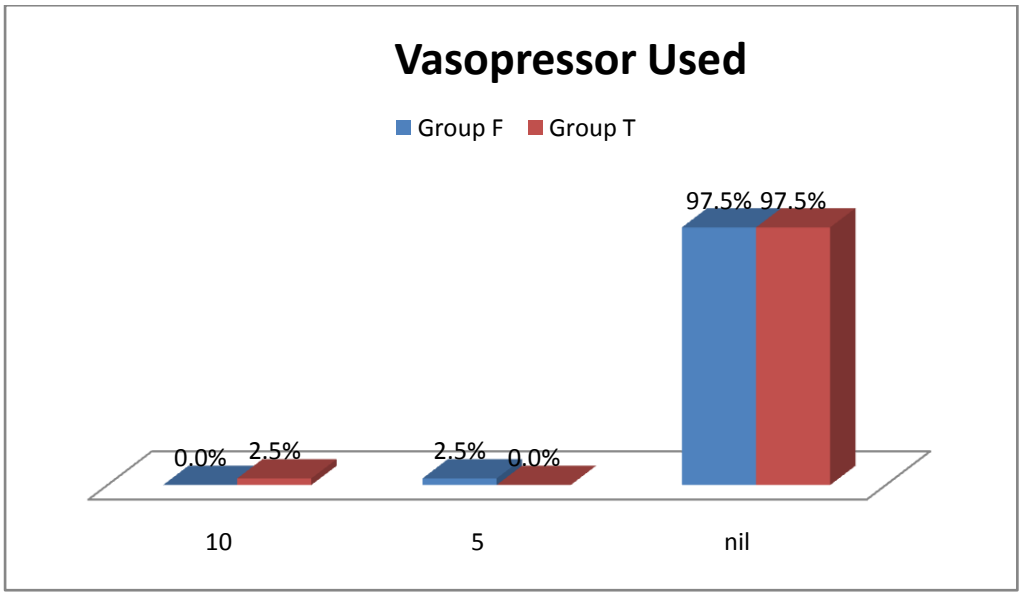


TABLE 13: COMPARISON OF BASELINE VITALS BETWEEN BOTH THE GROUPS.

	Group F		Group T		T	p-value
	Mean	SD	Mean	SD		
heart rate(bpm)	97.43	18.30	100.15	21.19	-0.615	0.540
SYSTOLIC NIBP(mmhg)	133.95	22.00	137.10	18.77	-0.689	0.493
DIASTOLIC (mmhg)	79.80	12.40	81.65	9.75	-0.742	0.460
SpO2(%)	96.38	4.68	96.78	3.24	-0.444	0.658

There was no statistically significant difference between baseline vitals of the patients between both the groups (p>0.05).

FIGURE 14: COMPARISON OF BASELINE VITALS BETWEEN BOTH THE GROUPS.

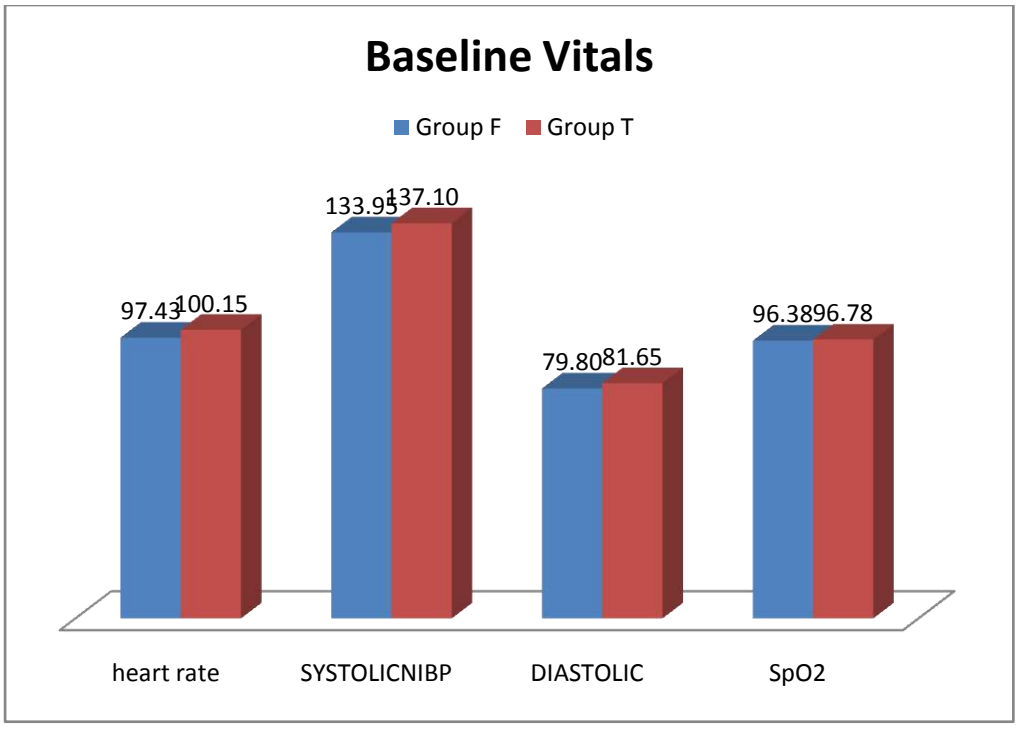


TABLE 14: COMPARISON OF SYSTOLIC BLOOD PRESSURE (SBP) OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

	Group F		Group T		T	p-value
	Mean	SD	Mean	SD		
SBP_1MIN	135.33	20.57	138.50	19.70	-0.705	0.483
SBP_2 min	138.33	21.18	139.13	18.63	-0.179	0.858
SBP_3 min	134.43	22.36	137.33	18.42	-0.633	0.528
SBP_4 min	133.15	23.78	136.33	20.34	-0.642	0.523
SBP_5 min	129.35	21.56	133.18	21.31	-0.798	0.427
SBP_6 min	130.08	23.57	129.90	24.81	0.032	0.974
SBP_7 min	130.88	23.37	126.78	27.54	0.718	0.475
SBP_8 min	130.78	23.97	124.15	26.68	1.168	0.246
SBP_9min	128.50	26.99	126.60	24.05	0.332	0.740
SBP_10 min	126.93	22.52	127.13	22.11	-0.040	0.968
SBP_11 min	128.45	20.88	127.18	20.45	0.276	0.783

FIGURE 15: COMPARISON OF SYSTOLIC BLOOD PRESSURE (SBP), OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

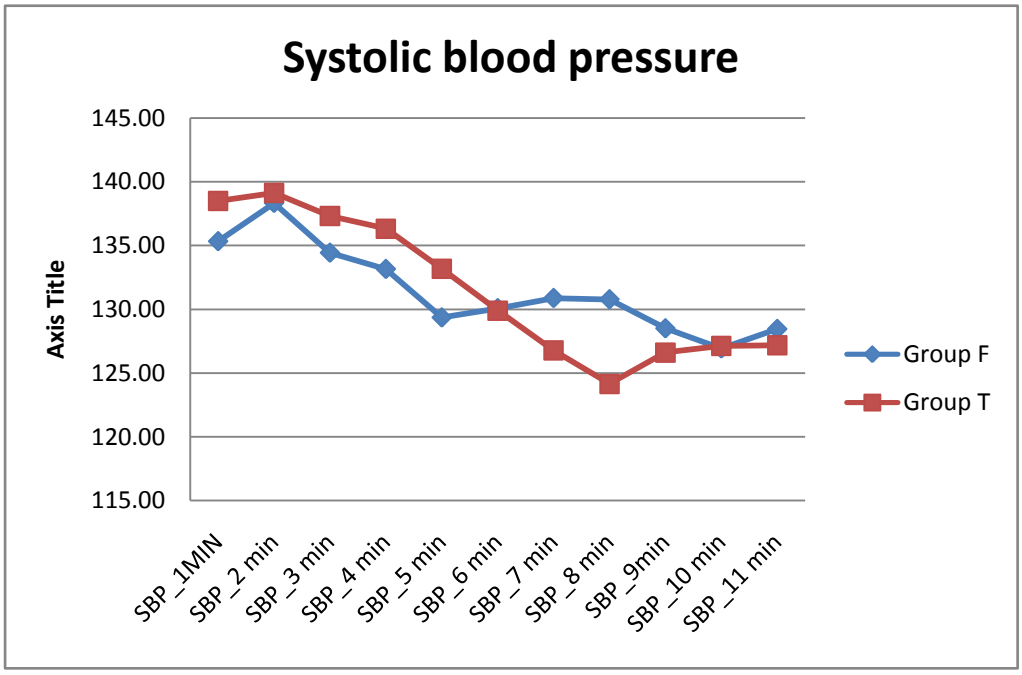


TABLE 15: COMPARISON OF DISATOLIC BLOOD PRESSURE (DBP), OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

	Group F		Group T		T	p-value
	Mean	SD	Mean	SD		
DBP_1MIN	82.50	10.33	83.73	11.47	-0.502	0.617
DBP_2 min	81.28	10.53	82.88	11.42	-0.651	0.517
DBP_3 min	80.10	12.08	84.28	11.13	-1.607	0.112
DBP_4 min	79.63	14.00	83.70	9.59	-1.518	0.133
DBP_5 min	78.73	14.28	81.25	10.36	-0.905	0.368
DBP_6 min	78.28	10.91	80.25	13.60	-0.716	0.476
DBP_7 min	77.73	12.20	77.85	13.85	-0.043	0.966
DBP_8 min	74.33	13.90	74.83	12.67	-0.168	0.867
DBP_9min	75.38	14.82	77.10	12.99	-0.554	0.581
DBP_10 min	76.93	13.72	75.78	12.30	0.395	0.694
DBP_11 min	77.60	12.30	76.10	11.34	0.567	0.572

FIGURE 16: COMPARISON OF DIASTOLIC BLOOD PRESSURE (DBP), OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

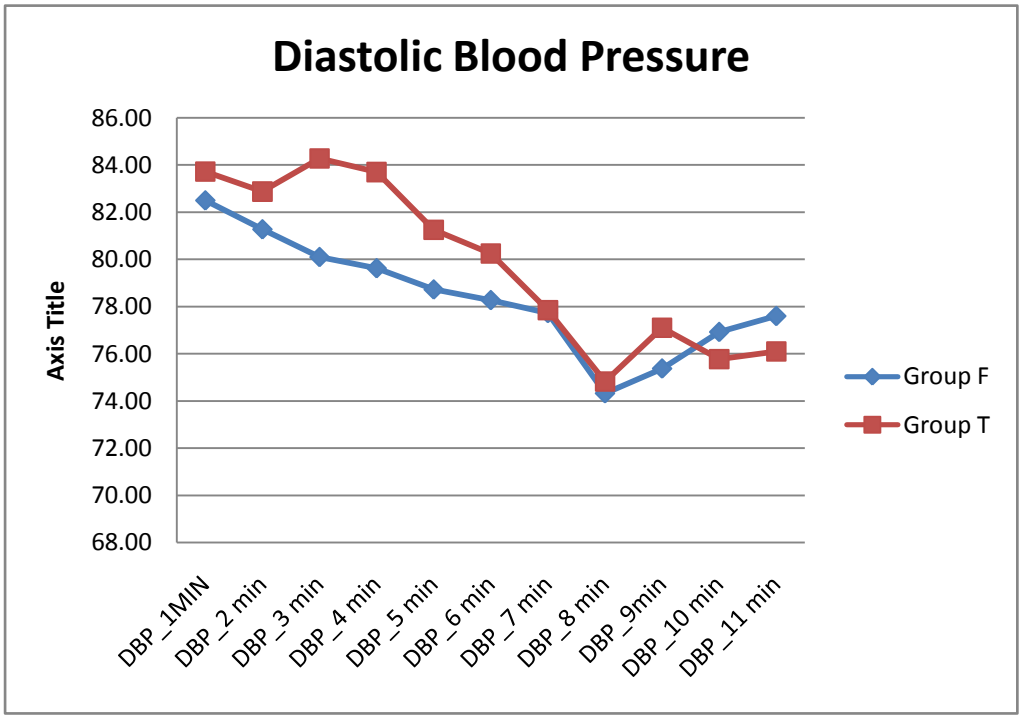


TABLE 16: COMPARISON OF HEART RATE (HR) OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

	Group F		Group T		t	p-value
	Mean	SD	Mean	SD		
HR_1MIN	94.60	19.15	95.88	18.59	-0.302	0.763
HR_2 min	94.88	18.43	96.25	19.48	-0.324	0.747
HR_3 min	95.28	18.25	96.93	17.52	-0.413	0.681
HR_4 min	96.70	17.82	96.28	18.29	0.105	0.916
HR_5 min	96.90	18.64	97.98	19.31	-0.253	0.801
HR_6 min	97.70	17.11	98.88	18.11	-0.298	0.766
HR_7 min	98.20	15.81	101.50	17.09	-0.897	0.373
HR_8 min	98.03	15.58	100.90	16.52	-0.801	0.426
HR_9min	97.50	15.52	99.59	17.39	-0.564	0.575
HR_10 min	96.62	14.49	100.39	16.06	-1.085	0.281
HR_11 min	96.62	14.39	97.54	17.06	-0.254	0.801

The difference between the systolic BP, diastolic BP and heart rate was found to be statistically insignificant between both the groups from the pre oxygenation till 5 minutes after intubation.

FIGURE 17: COMPARISON OF HEART RATE(HR) OF THE PATIENTS BETWEEN BOTH THE GROUPS FROM PRE-OXYGENATION TILL 5 MINUTES AFTER INTUBATION.

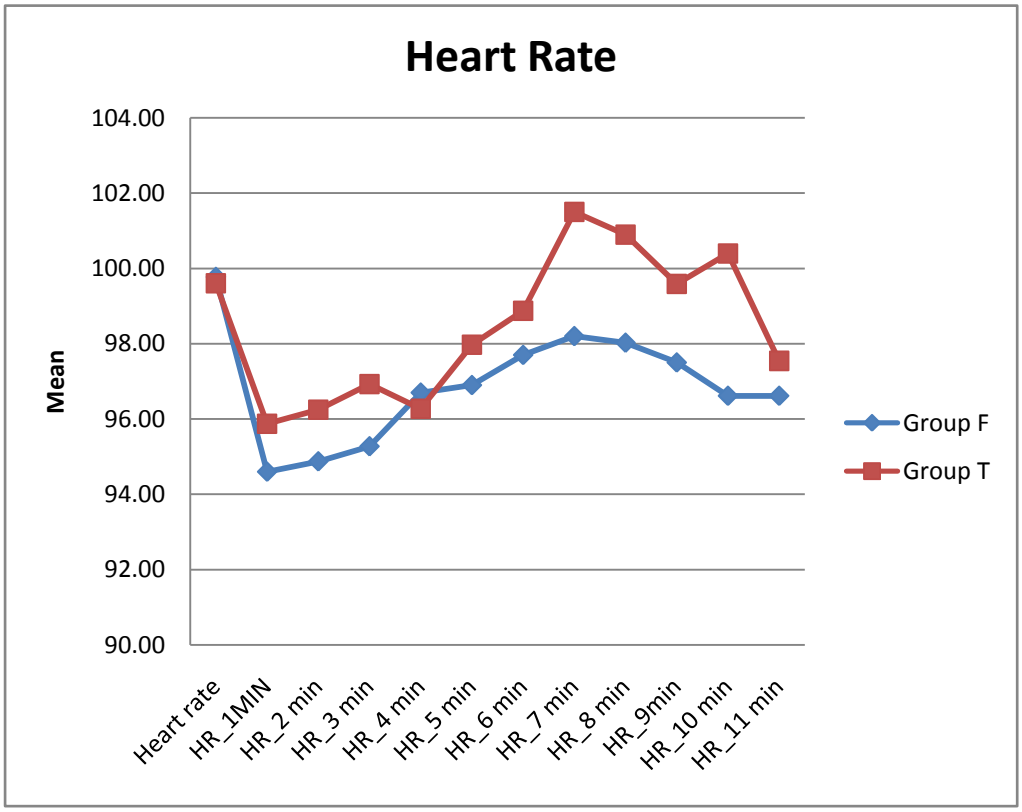


TABLE 17: COMPARISON OF PPOSSUM MORTALITY AND MORBIDITY % BETWEEN BOTH THE GROUPS.

	Group F		Group T		Z	p-value
	Mean	SD	Mean	SD		
P POSSUM SCORE Predicted Mortalty %	27.31	17.71	27.54	14.15	-0.063	0.950
P POSSUM SCORE Predicted Morbidity %	74.01	15.83	76.31	13.84	-0.693	0.490

P POSSUM Score was calculated using online medcalculator. The mean Mortality and morbidity % for patients in facemask group was 27.31±17.71 and 74.01±15.83 respectively and 27.54±14.15 and 76.31±13.84 for the patients pre-oxygenated with THRIVE. Thereby, no significant statistical difference was seen between the two groups in regard to PPOSSUM Score.

FIGURE 18a: COMPARISON OF PPOSSUM MORTALITY % BETWEEN BOTH THE GROUPS.

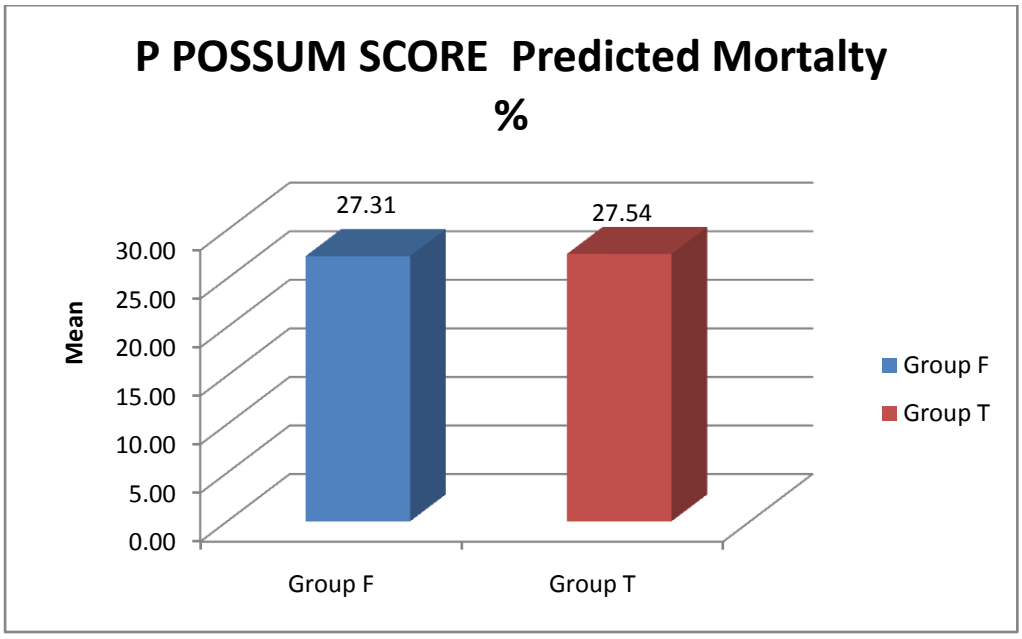
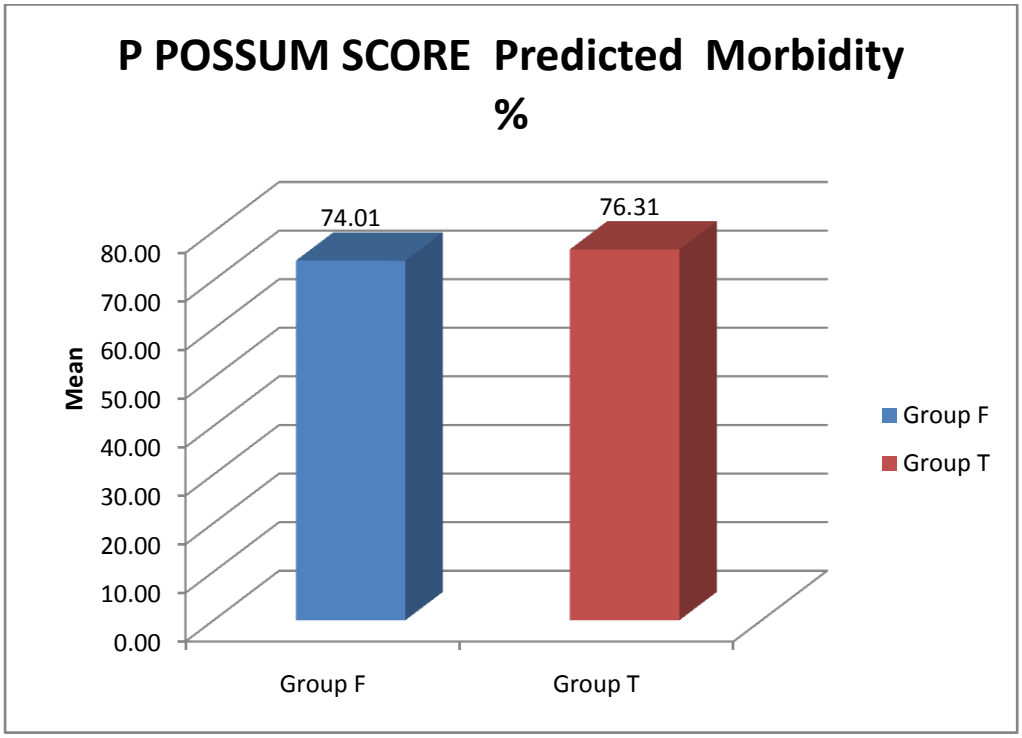


FIGURE 18b: COMPARISON OF PPOSSUM MORBIDITY % BETWEEN BOTH THE GROUPS.



DISCUSSION

Emergency and difficult tracheal intubations are grievous undertakings where successive laryngoscopy, hypoxemia and re-oxygenation cycles can cause loss of airway and can land us into the cannot intubate, cannot ventilate scenario.[14] Transnasal humidified rapid insufflation ventilatory exchange (THRIVE) is receiving growing attention as an alternative respiratory support in critical care settings and is used in patients with different underlying diseases.[43]There are several studies in literature confirming THRIVE as better and comfortable oxygenation device with lesser adverse effects.[44-47] Though current studies are very encouraging and promise a clinical benefit on patient's outcomes, randomized trials are still needed to demonstrate that THRIVE provides a better way of pre-oxygenation in different sets of population. Therefore in the present study we have compared the efficacy of pre-oxygenation with conventional facemask and THRIVE.

Our study included patients undergoing rapid sequence induction(RSI) for emergency abdomino-pelvic surgeries as induction of general anaesthesia in these patients is challenging due to their suboptimal circumstances and potential physiological derangements caused by their underlying illness.[16] A critically ill patient requiring emergency surgery is always considered as full stomach therefore positive pressure ventilation is usually prohibited and RSI is recommended in these sets of patients.[19]

Pre-oxygenation is pivotal component of RSI in order to increase the oxygen reservoir in the lungs for extending the safe apnoea time.[1] In our study, patients in facemask group were pre-oxygenated at flow rates of 12l/min with 100% oxygen whereas in THRIVE group flows were kept at 60l/min from pre-oxygenation and throughout apnoea period .A study conducted by Ng I et al showed significant rise in carbon dioxide(3.06 mmHg/minute)during apnoeic period in THRIVE group when oxygen flows were kept at 50l/min , whereas less increase in carbon dioxide (1.13 mmHg/ minute) was seen with oxygen flows at 70l/min in a study done by Patel et al.[14,48]So we kept flows of THRIVE

at 60l/min throughout the study period as lower flow rates could theoretically affect the carbon dioxide washout.[5,48,49] In our study PaO_2(as obtained from arterial blood gas analysis) and SpO_2 after successful intubation were compared as indicators of efficacy of pre-oxygenation in both the groups. We observed no significant difference in PaO_2 and SpO_2 values between both the groups and our findings were in concordance with results shown by previous studies.[16-18,37,39,40]

Similar to our study, Mir F et al and Lyon C et al evaluated PaO_2 as marker of efficacy of pre-oxygenation with THRIVE in patients undergoing general anaesthesia for emergency and non emergency surgeries respectively.[16,37] Mir et al compared PaO_2 ,$PaCO_2$, pH and lactates post intubation between both the groups and found no significance difference between them. In study by Lyon C et al subjects were divided into three groups - facemask, high flow nasal oxygenation (HFNO) and HFNO with mouth piece. They compared PaO_2 values after 3 minutes of preoxygenation among the three groups.[37]Zhen Hua et al also explored the efficacy of preoxygenation with conventional facemask and THRIVE during general anaesthesia in elderly patients (65yr to 80 yr). All the aforementioned authors observed no significant change in PaO_2 with THRIVE when compared with facemask.[16,18,37]

Moreover, in contrast to our study Yasser et al studied THRIVE in pregnant patients undergoing C-section under general anaesthesia. They observed significantly increased PaO_2 ($p<0.01$) after 3 minutes of apnoea period when compared with facemask with no difference in $PaCO_2$. The reason for this might be that THRIVE could provide a stable high FiO2 , positive end-expiratory pressure effect, washout of anatomical dead space and bypass of a suboptimal seal when compared to the standard facemask pre-oxygenation technique in pregnant females with lower baseline functional residual capacity.[38]

Other studies which compared the efficacy of pre-oxygenation between conventional facemask and THRIVE have mainly observed the early drop of peripheral saturation during apnoea as their primary outcome in both the groups.[17,37,39] In line with our findings Lodenius et al

observed statistically insignificant difference in the median lowest SpO2 during apnoea until 1 min after the tracheal intubation following pre-oxygenation with traditional facemask and THRIVE in patients undergoing RSI for emergency surgeries.[17] In our study the median lowest SpO2 was 97.5% and 97% in facemask and THRIVE group respectively.[17] The slightly lower SpO2 levels in THRIVE group was probably due to desaturation of one of the obese patient with BMI -36 kg/m^2 below 90% in apnoeic period in contrast to none in facemask group.

Our finding was also consistent with comparative study conducted by Sjoblom et al where they observed non significant difference in lowest median SpO_2 values between conventional facemask and THRIVE preoxygenation on 350 adult patients undergoing RSI for emergency surgeries.[40]

Patel et al applied THRIVE for pre-oxygenation in 25 adult patients with difficult airway anatomy and found THRIVE to safely extend apnoea time upto 17 minutes without any patient desaturating ≤90%.[14] Rajan et al also reported significant increase in safe apnoea with THRIVE when compared with conventional facemask along with nasopharyngeal catheter.[41] However, we did not study the safe apnoea period in our critically ill patients and apnoea time noted was recorded. Apnoea time was defined as the period from the start of apnoea till the appearance of well-formed waveform capnogram immediately after tracheal intubation. We did not find a significant difference between apnoeatime in both the groups. On contrary to our study Mir et al observed significant increase in apnoea time in THRIVE group and explained it due to knowledge bias resulting in controlled and careful laryngoscopy in THRIVE group.[16]

Number of attempts of laryngoscopy and use of manoeuvre to rescue desaturation below 90% were comparable in both the groups. Trachea of all patients were intubated at first attempt of laryngoscopy in our study. These findings were similar with observations reported by Lodenius et al, Zhen hua et al and Sjoblom et al.[17,18,40] Though one of the obese patient in THRIVE group in our study desaturated below 90%

and bag mask ventilation was used as rescue manoeuvre, this difference was insignificant in both the groups. In contrast, none of the patient in study by Mir et al and Raineri et al experienced desaturation below 90%.[16,39] The observation of no desaturation in these two studies may be explained as though they included patients for emergency surgeries but with BMI ≤35kg/m^2 whereas in our study the cut off BMI was kept ≤40kg/m^2

In concordance with the findings reported by Zhen Hua et al and Rajan et al we did not find any significant difference in hemodynamic variables between both the groups in our study.[18,41]

Significant difference was found in PPOSSUM physiology scores between two groups in the study of Mir et al[16] whereas our study patients in both the groups were comparable with respect to Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM).[16] The reason for this could be as only emergency laparotomies were included in a limited time frame in our study.

The strength of our study lies in the fact that we evaluated the efficacy of THRIVE preoxygenation in patients scheduled for emergency abdomino-pelvic surgeries who are generally sick with poor cardiorespiratory reserves and are at higher risk of hypoxemia during induction of anaesthesia. Our observations favoured its use as a preoxygenation tool in these patients.

Inspite of our meticulous efforts, our study has few limitations:

- Our study did not include pregnant patients, patients with severe cardiorespiratory diseases and morbidly obese patients with BMI ≥40 so our results cannot guide practice in these patients.
- No difference in the PaO_2 between the two groups might have been the result of limited sample size. Since our study was time bound, sample size was not calculated hence we suggest that further studies with larger sample sizes are still needed to study the effect of THRIVE on PaO_2.

Based on the observations and results of our study, we conclude that though not superior to conventional face mask, THRIVE is a safe,

practicable and efficient pre-oxygenation tool during rapid sequence induction of general anaesthesia for patients undergoing emergency surgeries.

SUMMARY&CONCLUSION

The present study was conducted in the department of Anaesthesiology, Dayanand Medical College and Hospital, Ludhiana after getting approval from the Institutional Ethical Committee. The aim was to compare efficacy of preoxygenation with THRIVE and conventional facemask in patients undergoing RSI for emergency surgeries. Eighty patients belonging to ASA grade II,III or IV were included These patients were randomly allocated to either of the two study groups each by computer generated random numbers contained in sealed, sequentially numbered envelopes. A written informed consent was obtained from each patient.

GROUP T (THRIVE group): Patients were preoxygenated for three minutes with heated and humidified 100% oxygen via a high flow nasal cannula at flow of 60L/min using THRIVE and this flow was maintained until successful placement of the tracheal tube.

GROUP F (Facemask group): Patients were preoxygenated for three minutes with 100% oxygen via a tightly held snuggly fitting facemask at flow of 12 L/min using a circle system and this flow was maintained until laryngoscopy was attempted.

After preoxygention patients were induced using RSI and ABG sample was withdrawn from arterial cannula in situ after successful intubation for PaO2 analysis between both groups.SpO_2, apnoea time, no of attempts at laryngoscopy, use of rescue manoeuvres and adverse events were recorded during the study. Results were analysed statistically.

We observed that 1) In group F patients, mean PaO_2 (primary outcome)was 239±107.07mmHg and in group T it was 258±105.77 mmHg; which was statistically insignificant ($p>0.05$). 2) Lowest mean SPO_2 was found to be 97.5% in the facemask group and 97% in the THRIVE group which was statistically insignificant. 3) Median apnoea time in facemask group was 88.5second and 100 second in the THRIVE group. There was no statistically significant difference between two groups $p > 0.05$

Hence from the results we concluded that though not superior to conventional face mask, THRIVE is a safe, practicable and efficient pre-oxygenation tool during rapid sequence induction of general anaesthesia for patients undergoing emergency surgeries.

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SR NO.	MRD no.	Group	Age	Indication of Surgery	BMI	Gender	ASA grade	Modified Mallampati Score	Upper Lip Bite Test	Neck circumference (cm)	P POSSUM SCORE Predicted Mortalty	P POSSUM SCORE Predicted Morbidity	Baseline Hemodynamic and Respiratory Parameters						
													heart rate	ecg	SYSTOLIC NIBP	DIASTOLIC	SpO2	1MIN	2 min
1	1108230	T	34	MESENTRIC ISCHEMIA	20	M	IV	II	2	< 40	49.3	93.1	118	NSR	138	98	96	135	148
2	1121397	F	73	OBSTRUCTIONAL HERNIA	34	F	II	III	2	<40	28.5	82.6	103	S TACHY	135	61	97	140	137
3	1125438	F	55	BOWEL OBSTRUCTION	24	F	III	III	2	<40	9.2	46.5	79	NSR	130	81	98	124	130
4	197761	T	54	BOWEL OBSTRUCTION	54	M	II	IV	2	<40	13.7	59.9	75	NSR	150	96	98	155	144
5	1124855	F	51	SAIO	29	M	II	IV	2	<40	23.3	76.9	95	NSR	122	90	95	126	132
6	1130021	T	57	SAIO	27.5	M	III	IV	2	<40	19	70.7	117	S TACHY	130	88	95	129	130
7	1125186	F	56	INTESTINAL PERFORATION	37	M	III	IV	1	>40	71.7	97.6	134	S TACHY	97	67	95	106	96
8	1127726	T	46	SAIO	21	F	III	III	2	<40	63.6	96.6	139	S TACHY	119	87	98	123	128
9	999902	F	36	JEJUNAL STRICTURE	20	F	II	I	2	<40	13.7	59.9	70	NSR	164	80	100	163	163
10	1006839	F	36	RECTOVAGINAL FISTULA	22	F	III	III	2	<40	52.5	94	73	NSR	125	80	100	122	122
11	1130045	T	80	ENDOMETRIAL CARCINOMA	34	F	III	III	2	>40	12.2	56	96	NSR	190	84	96	194	177
12	1137485	T	37	OBSTRUCTIONAL HERNIA	23	M	II	I	2	<40	12.2	56	75	NSR	145	82	98	145	152
13	1136566	F	54	BOWEL OBSTRUCTION	24	M	II	III	2	<40	93	99.7	76	NSR	150	80	98	150	152
14	1138773	F	73	BOWEL OBSTRUCTION	30.2	M	IV	III	2	<40	23.3	76.9	109	S TACHY	170	96	94	170	170
15	1137982	F	62	BOWEL OBSTRUCTION	23	M	III	IV	2	<40	31	84.3	82	NSR	175	110	100	170	170
16	1142442	F	51	PERFORATED APPENDIX	37	M	III	II	2	<40	33.8	86.3	101	S TACHY	140	90	98	130	140
17	1163051	T	70	ILEAL PERFORATION	27	M	III	IV	2	40	33	86	118	S TACHY	165	96	98	150	150
18	1163403	T	65	GIT PERFORATION	20	M	III	II	2	<40	33	84	118	S TACHY	134	86	100	130	134
19	1126670	F	20	GIT PERFORATION	20	M	III	I	2	<40	12.2	56	103	S TACHY	112	76	99	120	130
20	1171261	F	60	SAIO	22	F	III	III	2	<40	35.2	87	93	NSR	150	100	96	160	170
21	1176067	F	27	ABDOMINAL PERFORATION	23	F	III	II	2	<40	33.8	86.3	118	S TACHY	96	56	92	106	160
22	1178343	F	75	SAIO	24	F	IV	IV	2	<40	36.8	88.1	82	NSR	150	62	91	140	138
23	1180343	F	60	SAIO	21	F	III	IV	2	<40	28.3	82.1	103	S TACHY	168	103	100	170	175
24	1174240	T	51	SAIO	31	F	III	III	2	<40	44.5	91.2	90	NSR	150	90	94	160	148
25	1152106	F	48	SAIO	24	F	III	I	2	<40	12.2	56	107	S TACHY	132	83	98	110	120
26	1189631	F	35	OBSTRUCTIONAL HERNIA	39	F	IV	IV	2	<40	10.9	52	76	NSR	168	99	100	158	160
27	1190676	F	47	BOWEL PERFORATION	26	F	III	II	2	<40	36.8	88.1	130	S TACHY	110	70	98	133	133
28	1186114	T	51	OBSTRUCTIONAL HERNIA	22.4	M	III	II	2	<40	21.1	73.9	55	S BRADY	130	80	100	153	153
29	1198633	T	60	SAIO	29	M	III	III	2	<40	32.3	85.1	76	NSR	150	100	91	153	153
30	1197845	F	63	GANGRENE BOWEL	22	F	IV	III	2	<40	56	95	148	S TACHY	140	80	91	140	144
31	1199093	F	62	OBSTRUCTIONAL HERNIA	30	M	IV	III	2	<40	33.8	86.3	106	S TACHY	180	100	100	185	180
32	1200152	F	50	SAIO	23	M	II	III	2	<40	9.7	48	74	NSR	130	90	95	154	160
33	1202459	T	47	BOWEL PERFORATION	36	M	III	III	2	<40	63.4	96.4	128	S TACHY	100	60	91	106	110
34	1201885	T	55	BOWEL OBSTRUCTION	30	M	IV	III	2	<40	24.4	77.9	76	NSR	150	100	100	150	154
35	1203338	F	25	BOWEL OBSTRUCTION	22	M	IV	III	2	<40	31	84.3	114	S TACHY	90	60	98	100	90
36	1206039	F	50	SAIO	26	F	IV	II	2	<40	15.3	63.6	94	NSR	120	80	98	123	120
37	1206070	F	53	SAIO	35	M	III	IV	2	<40	19	70.7	108	S TACHY	140	80	97	140	138
38	1213305	T	52	OBSTRUCTIONAL HERNIA	23	M	IV	III	2	<40	43	91.1	96	NSR	110	60	96	100	112
39	1215097	F	31	BLUNT TRAUMA ABDOMEN	22	M	IV	II	2	<40	44.3	91.2	99	NSR	138	64	96	140	138
40	1215181	T	80	SAIO	23	M	III	II	2	<40	28.3	82.1	126	S TACHY	120	80	100	160	170
41	1113713	F	50	GIT OBSTRUCTION	23	F	III	II	2	<40	15.3	63.6	104	S TACHY	130	80	100	135	135
42	1215521	T	31	SAIO	23	F	III	II	2	<40	8.6	44	90	NSR	130	80	98	130	129
43	1198633	F	60	SAIO	26	M	III	II	2	<40	8.6	44	80	NSR	130	80	100	128	130
44	1225192	F	65	OBSTRUCTIONAL HERNIA	28	M	III	III	2	<40	12.2	56	100	S TACHY	158	90	95	160	158
45	1228319	T	69	SAIO	28	M	IV	III	2	<40	13.7	59.9	120	S TACHY	110	70	95	110	104

SR NO.	MRD no.	SYSTOLIC NIBP									DIASTOLIC NIBP											SpO2						
		3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11 min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11 min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min
1	1108230	140	136	136	130	130	132	128	124	130	100	98	94	92	93	95	100	94	90	84	80	97	100	100	100	100	100	100
2	1121397	120	106	107	110	130	120	105	110	112	70	77	80	50	50	70	80	70	60	70	64	99	98	95	92	90	88	92
3	1125438	130	128	134	130	140	195	188	174	176	78	79	79	75	85	80	80	110	122	120	126	98	100	100	100	100	100	100
4	197761	144	150	160	170	200	180	178	173	142	100	90	100	100	90	90	100	100	115	106	88	99	100	100	100	100	100	100
5	1124855	134	118	124	120	130	140	142	153	148	96	90	93	88	92	90	90	80	90	96	100	100	100	100	100	100	100	100
6	1130021	150	154	130	152	126	112	110	100	100	90	90	80	90	80	104	84	71	70	60	70	97	95	93	91	97	100	99
7	1125186	111	106	100	101	130	121	120	110	110	60	68	51	61	70	78	80	80	78	70	70	97	97	98	97	95	99	99
8	1127726	121	123	120	142	133	100	126	103	130	89	90	91	86	87	100	92	70	82	65	70	100	100	100	100	100	100	100
9	999902	160	162	150	152	135	130	130	128	130	86	84	80	86	60	84	67	60	64	68	70	100	100	100	100	100	100	100
10	1006839	124	130	120	132	136	140	145	142	140	80	80	84	82	80	84	80	100	110	92	90	100	100	100	100	100	100	100
11	1130045	180	176	165	168	184	190	200	200	190	83	80	103	76	80	86	95	100	110	110	100	98	100	100	100	100	100	100
12	1137485	140	142	150	160	166	170	162	160	148	88	90	92	83	80	80	88	90	89	80	82	100	100	100	100	100	100	100
13	1136566	155	150	154	152	157	160	152	150	154	80	82	85	80	82	84	82	88	80	78	80	100	100	100	100	99	99	99
14	1138773	160	172	116	170	180	170	180	152	140	90	90	100	114	110	70	72	70	72	64	70	97	97	99	99	98	98	99
15	1137982	160	172	116	170	180	170	180	152	140	91	91	101	115	111	71	73	71	73	65	78	99	99	100	100	100	100	100
16	1142442	132	140	130	132	140	142	144	140	138	80	90	92	80	80	80	90	80	88	80	82	95	96	94	99	98	99	100
17	1163051	150	150	150	150	150	150	150	140	144	90	91	92	93	94	95	96	97	98	80	82	99	100	100	100	99	99	97
18	1163403	136	145	140	145	150	155	150	155	150	80	84	82	96	80	85	80	85	80	80	80	100	100	100	100	100	100	100
19	1126670	90	110	120	130	120	102	90	92	90	80	80	50	70	80	76	76	60	55	55	90	100	100	100	100	100	100	100
20	1171261	170	150	155	140	145	148	150	152	150	100	100	100	90	90	90	82	70	80	82	80	96	99	100	100	100	100	100
21	1176067	104	96	100	115	117	121	125	120	121	70	72	71	60	60	80	78	70	75	70	70	92	99	100	100	100	100	100
22	1178343	110	100	102	73	81	103	115	110	111	80	82	70	60	50	53	50	58	64	70	70	97	98	99	98	97	98	98
23	1180343	168	170	175	172	168	166	169	160	155	100	102	98	98	100	92	90	82	80	80	80	99	99	100	100	100	100	100
24	1174240	140	135	130	135	130	128	130	133	140	80	95	90	90	90	91	70	70	72	70	70	94	99	100	100	100	100	100
25	1152106	124	120	130	133	120	121	120	100	100	70	80	82	80	80	88	80	63	60	100	100	100	100	100	100	100	100	100
26	1189631	161	160	158	152	152	156	148	160	162	90	84	84	84	82	80	80	70	80	80	80	100	100	100	100	100	100	100
27	1190676	131	144	142	100	89	121	116	120	121	80	80	79	81	82	63	52	70	73	70	70	98	98	99	100	100	100	100
28	1186114	154	158	130	126	120	117	110	130	128	100	101	100	100	90	91	80	70	70	80	90	100	100	100	100	100	100	100
29	1198633	154	159	138	126	120	116	110	130	128	100	101	100	100	90	99	80	70	70	80	90	100	100	100	100	100	100	100
30	1197845	133	130	138	126	120	116	110	130	128	80	78	78	80	91	100	81	71	71	81	91	100	100	100	100	100	100	100
31	1199093	170	177	170	168	160	160	158	150	150	110	110	90	90	80	80	78	80	72	80	70	100	100	100	100	100	100	100
32	1200152	190	193	180	168	166	169	170	157	139	98	100	100	100	100	95	110	111	100	99	87	100	100	100	100	100	100	100
33	1202459	100	90	94	90	92	90	90	88	88	62	63	60	60	64	60	52	54	60	50	52	91	90	92	100	100	100	100
34	1201885	152	148	160	164	160	162	170	160	166	100	92	90	82	90	92	82	92	90	80	72	100	100	100	100	99	99	100
35	1203338	92	90	100	110	128	100	90	90	100	60	50	64	50	60	70	80	60	60	50	60	98	98	99	100	100	100	100
36	1206039	117	110	100	128	130	140	150	148	160	83	83	81	70	60	80	90	90	90	90	80	98	97	98	100	100	100	100
37	1206070	140	142	155	160	150	140	130	128	110	80	80	80	85	90	90	90	70	70	82	70	96	97	97	100	96	96	97
38	1213305	114	130	128	110	100	90	100	110	100	60	64	62	80	70	70	70	60	70	70	60	96	95	96	100	100	100	100
39	1215097	140	142	155	160	150	140	130	128	110	80	80	80	85	90	90	90	70	70	82	70	96	95	96	100	98	99	100
40	1215181	170	150	120	110	100	90	110	120	140	80	80	80	80	72	70	60	50	70	80	80	99	100	100	100	100	99	100
41	1113713	128	132	135	125	110	100	120	135	140	88	89	90	91	92	93	94	95	96	97	90	100	100	100	100	100	100	100
42	1215521	120	110	110	100	100	110	110	120	110	80	80	80	80	70	60	70	70	80	80	80	97	99	97	100	100	100	100
43	1198633	130	120	122	110	110	114	100	111	110	80	80	80	80	82	70	70	72	60	62	70	100	100	100	100	100	100	100
44	1225192	150	150	130	126	122	120	100	100	160	100	78	98	98	86	84	80	80	70	60	70	95	95	96	100	99	100	100
45	1228319	110	110	100	96	90	110	120	130	120	70	64	78	70	60	62	50	70	80	80	80	95	94	94	100	100	100	100

SR NO.	MRD no.	Heart rate																Attempts of laryngoscopy	Method of laryngoscopy	cormack lehane score	any rescue manoeuvre		Bl
		8 min	9min	10 min	11 min	12min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11min				LMA	Bag and mask	SPO2 less than 90%
1	1108230	100	100	100	100	-	118	112	111	115	117	119	118	107	110	112	-	1	CONVENTIONAL	I	NO	NO	NIL
2	1121397	98	98	98	97	-	101	109	110	117	119	113	107	114	110	105	107	1	CONVENTIONAL	II	NO	NO	NIL
3	1125438	100	100	100	100	-	74	83	75	83	85	90	92	100	95	90	92	1	CONVENTIONAL	III	NO	NO	NIL
4	197761	100	100	100	100	-	74	81	79	80	82	83	80	106	100	90	75	1	VIDEOLARYNGOSCOPE	I	NO	NO	NIL
5	1124855	100	100	100	100	-	90	88	86	96	95	92	94	95	94	96	92	1	VIDEOLARYNGOSCOPE	II	NO	NO	NIL
6	1130021	98	99	100	100	-	116	116	117	116	116	112	111	107	-	-	-	1	CONVENTIONAL	II	NO	NO	NIL
7	1125186	97	96	99	100	-	134	133	134	132	145	145	143	142	140	-	-	1	VIDEOLARYNGOSCOPE	II	NO	NO	NIL
8	1127726	100	100	100	100	-	129	130	127	122	118	123	121	117	120	119	-	1	VIDEOLARYNGOSCOPE	I	NO	NO	NIL
9	999902	100	100	100	100	100	62	67	64	60	60	62	59	60	65	70	70	1	CONVENTIONAL	II	NO	NO	NIL
10	1006839	100	100	100	100	100	63	68	70	72	72	74	80	86	90	88	90	1	CONVENTIONAL	II	NO	NO	NIL
11	1130045	100	100	100	100	-	94	92	94	94	92	85	98	99	101	103	-	1	CONVENTIONAL	II	NO	NO	NIL
12	1137485	100	100	100	100	-	75	70	86	73	80	88	82	90	95	100	98	1	CONVENTIONAL	II	NO	NO	NIL
13	1136566	100	100	100	100	-	72	75	73	76	78	81	85	90	92	93	90	1	CONVENTIONAL	II	NO	NO	NIL
14	1138773	97	96	96	96	96	110	109	105	102	109	109	108	110	107	107	107	1	VIDEOLARYNGOSCOPE	II	NO	NO	NIL
15	1137982	100	100	100	100	100	88	89	90	92	99	100	99	102	98	92	89	1	VIDEOLARYNGOSCOPE	II	NO	NO	NIL
16	1142442	100	99	99	100	98	92	96	95	96	98	100	102	100	104	106	108	1	CONVENTIONAL	II	NO	NO	NIL
17	1163051	100	100	100	100	-	113	111	102	110	111	107	112	103	106	-	-	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
18	1163403	100	100	100	100	100	112	130	133	134	137	139	129	124	120	122	120	1	CONVENTIONAL	II	NO	NO	NIL
19	1126670	100	100	100	100	100	90	92	102	104	103	102	103	95	95	91	91	1	CONVENTIONAL	I	NO	NO	NIL
20	1171261	100	100	100	100	100	81	74	71	94	92	90	88	87	85	90	91	1	CONVENTIONAL	I	NO	NO	NIL
21	1176067	100	100	100	100	100	115	113	112	111	112	111	114	112	113	114	114	1	CONVENTIONAL	III	NO	NO	NIL
22	1178343	97	96	99	99	100	110	112	113	118	119	117	120	118	120	124	120	1	CONVENTIONAL	II	NO	NO	NIL
23	1180343	100	100	100	100	100	103	105	106	108	110	112	109	110	109	110	115	2	CONVENTIONAL	III	NO	NO	NIL
24	1174240	100	100	100	100	100	86	87	88	89	90	92	90	88	86	90	86	1	CONVENTIONAL	II	NO	NO	NIL
25	1152106	100	100	100	100	100	110	112	113	111	90	90	85	82	78	79	82	1	CONVENTIONAL	I	NO	NO	NIL
26	1189631	100	100	100	100	100	64	68	70	64	70	74	78	80	85	80	90	1	CONVENTIONAL	II	NO	NO	NIL
27	1190676	100	100	100	100	100	111	110	120	118	112	114	110	100	101	100	102	1	CONVENTIONAL	II	NO	NO	NIL
28	1186114	100	100	100	100	100	54	54	55	56	61	73	74	72	70	75	75	1	CONVENTIONAL	II	NO	NO	NIL
29	1198633	100	100	100	100	100	72	73	70	75	72	70	82	80	70	88	82	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
30	1197845	100	100	100	100	100	147	145	142	130	132	128	125	130	133	135	138	2	CONVENTIONAL	II	NO	NO	NIL
31	1199093	100	100	100	100	100	107	105	104	103	100	102	101	100	105	104	100	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
32	1200152	100	100	100	99	99	74	68	69	70	69	85	91	99	86	85	80	1	CONVENTIONAL	II	NO	NO	NIL
33	1202459	100	100	100	100	98	132	142	140	130	132	130	135	140	144	142	142	1	VIDEOLARYNGOSCOPE	II	NO	NO	NIL
34	1201885	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
35	1203338	100	100	100	100	100	112	110	100	110	110	111	112	110	111	114	116	1	VIDEOLARYNGOSCOPE	I	NO	NO	NIL
36	1206039	100	100	100	100	100	90	92	94	94	95	98	99	100	102	109	110	1	CONVENTIONAL	I	NO	NO	NIL
37	1206070	98	100	100	100	100	108	107	108	110	115	116	118	115	114	118	114	1	CONVENTIONAL	II	NO	NO	NIL
38	1213305	100	100	100	100	100	90	92	100	99	98	98	96	100	98	99	100	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
39	1215097	100	100	100	100	100	100	98	98	112	114	120	100	100	98	98	95	1	CONVENTIONAL	III	NO	NO	NIL
40	1215181	100	99	100	100	99	75	74	72	80	82	80	82	85	88	90	90	1	CONVENTIONAL	II	NO	NO	NIL
41	1113713	100	100	100	100	100	106	105	104	100	98	98	100	100	102	106	108	1	CONVENTIONAL	II	NO	NO	NIL
42	1215521	100	100	100	100	100	90	92	90	88	95	98	100	96	98	98	96	2	CONVENTIONAL	II	NO	NO	NIL
43	1198633	100	100	100	100	100	80	82	80	85	90	92	98	98	92	96	92	1	CONVENTIONAL	II	NO	NO	NIL
44	1225192	100	100	100	100	100	97	95	99	98	95	92	90	96	99	98	95	1	CONVENTIONAL	II	NO	NO	NIL
45	1228319	100	100	100	100	100	120	118	110	115	120	125	130	128	122	120	118	1	CONVENTIONAL	II	NO	NO	NIL

SR NO.	MRD no.	aseline ABG values				After successful intuabtion					Experience of laryngoscopist in years				apnoea time	minimum spo2	vasopresser used ml/hr(80mcg/ml)	PAO2 (kPa) after intubation	PaO2 (kPa) baseline
		PaO2	PaCO2	Ph	HCO3	lactates	PaO2	PaCO2	Ph	HCO3	lactates	3-5 yrs	6-10 yrs	≥11 yrs	SECONDS				
1	1108230	99	31	7.47	22.6	1.1	228	43	7.37	24.9	1.1	-	yes	-	60	96	nil	30.3	13.1
2	1121397	79	38	7.32	19.6	0.7	72	47	7.24	20.1	0.8	-	yes	-	87	88	nil	9.5	10.53
3	1125438	87	36	7.44	24.5	1.1	209	52	7.33	27.4	1	-	yes	-	70	98	nil	27.8	11.59
4	197761	72	36	7.44	24.5	0.5	170	52	7.32	26.8	0.8	-	yes	-	89	98	nil	22.6	9.5
5	1124855	98	41	7.42	26.6	0.8	322	50	7.32	25.8	0.9	-	yes	-	80	93	nil	42.9	13.06
6	1130021	68	35	7.53	29.2	1.1	71	45	7.41	28.5	1	-	yes	-	68	91	nil	9.4	9.06
7	1125186	64	31	7.54	26.5	2	65	50	7.33	26.4	3.4	-	yes	-	70	91	nil	8.6	8.53
8	1127726	65	34	7.5	26.5	2.5	228	44	7.42	28.5	3	-	yes	-	75	97	nil	30.3	8.66
9	999902	100	38	7.48	28.8	2.1	450	39	7.46	27.7	1.8	-	-	yes	70	99	nil	59.9	13.33
10	1006839	99	37	7.42	24	0.7	326	42	7.35	23.2	1.6	-	-	yes	87	100	nil	43.4	13.19
11	1130045	76	42	7.42	27.2	2.1	193	23	7.34	26	0.9	-	-	yes	150	95	nil	25.7	10.13
12	1137485	90	34	7.41	23	1	180	37	7.37	22	0.7	-	yes	-	80	97	nil	23.9	11.99
13	1136566	177	38	7.5	29.6	1	267	48	7.43	31.9	0.9	yes	-	-	115	97	nil	35.5	23.59
14	1138773	64	34	7.41	23.5	0.9	261	47	7.31	23.7	1.2	-	yes	-	72	94	nil	34.7	8.53
15	1137982	88	34	7.4	22	1	220	40	7.3	24	0.8	-	yes	-	80	97	nil	29.3	11.73
16	1142442	74	34	7.43	22.6	1.3	110	47	7.32	24.2	1.1	-	-	yes	94	92	nil	14.6	9.86
17	1163051	80	34	7.4	24	1	101	46	7.33	24.3	1.5	-	yes	-	80	97	nil	13.4	10.66
18	1163403	79	31	7.33	16.3	3.6	445	54	7.13	18	4.3	-	yes	-	70	100	nil	59.3	10.53
19	1126670	91	35	7.48	26.1	0.4	452	36	7.46	25.6	0.8	-	-	yes	80	98	nil	60.2	12.13
20	1171261	67	44	7.49	33.5	0.9	375	50	7.45	34.8	1.1	-	-	yes	105	94	nil	49.9	8.93
21	1176067	83	28	7.37	16.2	2.1	351	38	7.28	17.9	2.3	-	yes	-	70	91	nil	46.7	11.06
22	1178343	99	25	7.23	10.5	5.1	60	43	7.1	13.3	3.6	-	yes	-	100	90	5	7.9	13.19
23	1180343	114	37	7.4	22.9	0.7	308	41	7.36	23.2	0.6	-	-	yes	140	99	nil	41	15.19
24	1174240	72	37	7.51	29.5	0.7	184	37	7.46	26.3	0.9	-	yes	-	80	93	nil	24.5	9.59
25	1152106	92	40	7.45	27.8	0.5	367	49	7.37	26.9	0.5	yes	-	-	80	98	nil	48.9	12.26
26	1189631	89	38	7.45	26.4	0.8	132	47	7.35	25.9	0.7	-	yes	-	130	100	nil	17.5	11.86
27	1190676	98	33	7.4	20.4	3.1	378	37	7.35	20.4	1.3	yes	-	-	98	98	nil	50.3	13.06
28	1186114	88	37	7.51	29.5	1.9	274	4.3	7.43	28.5	1.8	yes	-	-	105	99	nil	36.5	11.73
29	1198633	133	41	7.47	29.6	0.6	371	43	7.44	29.2	0.8	-	-	yes	150	91	nil	49.4	17.73
30	1197845	180	26	7.52	21.2	1.6	125	52	7.3	25.6	1.7	-	yes	-	80	91	nil	16.6	23.99
31	1199093	82	32	7.39	21.8	0.6	343	41	7.36	23.2	0.6	-	yes	-	102	99	nil	45.7	10.93
32	1200152	93	34	7.45	23.6	0.6	353	49	7.33	25.8	0.6	-	yes	-	76	95	nil	47	12.39
33	1202459	65	29	7.33	15.3	3.8	73	46	7.17	16.8	3.8	-	yes	-	57	91	10	9.7	8.66
34	1201885	105	35	7.44	23.8	0.4	220	40	7.4	25.4	0.5	-	yes	-	110	99	nil	29.3	13.99
35	1203338	105	32	7.22	13.1	5.5	65	39	7.29	18.8	3.5	-	yes	-	70	90	nil	8.6	13.99
36	1206039	95	30	7.49	22.9	2.1	165	38	7.41	24.1	1.4	-	yes	-	102	97	nil	21.9	12.66
37	1206070	70	34	7.52	28.8	1.1	87	39	7.47	28.4	0.8	-	yes	-	90	96	nil	11.5	9.33
38	1213305	88	21	7.45	14.6	2.3	313	28	7.34	15.1	2.1	-	yes	-	60	96	nil	41.7	11.73
39	1215097	66	38	7.41	24.1	0.5	300	47	7.31	23.7	0.6	-	yes	-	119	95	nil	39.9	8.79
40	1215181	65	36	7.52	29	1.6	205	52	7.33	27.4	1.4	-	yes	-	80	99	nil	27.3	8.66
41	1113713	122	34	7.39	20.6	0.8	288	51	7.26	22.9	1.3	yes	-	-	74	99	nil	38.3	16.26
42	1215521	182	29	7.55	25.4	0.5	395	38	7.44	25.8	0.5	-	-	yes	89	97	nil	52.66	24.26
43	1198633	90	32	7.47	23.3	0.7	300	48	7.36	27.1	0.7	-	yes	-	60	99	nil	39.9	11.99
44	1225192	64	36	7.47	26.2	0.6	123	35	7.36	26.4	0.6	-	yes	-	80	95	nil	16.3	8.53
45	1228319	93	34	7.45	23.6	0.6	353	49	7.33	25.8	0.6	-	yes	-	120	99	nil	47	12.39

SR NO.	MRD no.	Group	Age	Indication of Surgery	BMI	Gender	ASA grade	Modified Mallampati Score	Upper Lip Bite Test	Neck circumference (cm)	P POSSUM SCORE Predicted Mortalty	P POSSUM SCORE Predicted Morbidity	Baseline Hemodynamic and Respiratory Parameters						
													heart rate	ecg	SYSTOLIC NIBP	DIASTOLIC	SpO2	1MIN	2 min
46	1231907	T	72	OBSTRUCTIONAL HERNIA	21	M	III	II	2	<40	36.8	88.1	108	S TACHY	160	80	99	150	166
47	1232967	F	52	SAIO	26	M	III	III	2	<40	11.3	53.7	72	NSR	124	74	99	120	124
48	1195093	T	34	GIT PERFORATION	29	M	IV	III	2	<40	19	70.7	104	S TACHY	144	82	99	154	143
49	1128919	T	38	BOWEL PERFORATION	28	M	III	III	2	<40	17.1	67.3	100	S TACHY	120	80	98	130	129
50	178901	T	60	BOWEL PERFORATION	36	F	III	II	2	<40	28.3	82.1	104	S TACHY	150	90	93	150	154
51	1294887	F	68	OBSTRUCTIONAL HERNIA	25	F	IV	III	2	<40	25.7	79.6	108	S TACHY	120	70	88	120	124
52	370768	F	58	GIT OBSTRUCTION	22	M	III	IV	2	<40	43	91.1	82	NSR	114	70	100	120	122
53	1254586	T	60	GIT PERFORATION	22	F	III	II	2	<40	25	79.6	100	S TACHY	150	80	99	150	148
54	1252144	T	75	GIT PERFORATION	35	F	IV	II	2	<40	31	84.3	84	NSR	150	78	87	150	148
55	1279983	F	21	ILEAL PERFORATION	17	F	IV	III	2	<40	18.4	69.2	118	NSR	110	70	98	120	124
56	1280904	F	37	PERFORATED APPENDIX	25	M	IV	III	2	<40	25.7	79.6	103	S TACHY	120	70	99	120	118
57	1000381	T	70	BOWEL OBSTRUCTION	23	M	III	II	2	<40	33.8	86.3	100	S TACHY	130	80	90	150	155
58	924330	T	65	SAIO	23	F	III	III	2	<40	31	84.3	80	NSR	120	80	95	130	128
59	1292753	F	22	SAIO	23	M	IV	II	2	<40	23.3	76.9	120	S TACHY	130	80	99	130	128
60	1293628	F	67	SAIO	27	F	IV	II	2	<40	28.3	82.1	104	S TACHY	110	70	99	110	112
61	1294887	F	66	OBSTRUCTIONAL HERNIA	30	F	IV	II	2	<40	25.7	79.6	74	NSR	130	80	82	130	132
62	1316455	F	52	PERFORATED APPENDIX	38	M	IV	IV	2	<40	15.3	63.6	90	NSR	120	80	80	120	124
63	1317504	F	24	GIT PERFORATION	22	M	IV	III	2	<40	10.9	52	90	NSR	130	80	92	130	132
64	1323343	T	19	BOWEL PERFORATION	19	M	III	II	2	<40	19	70.7	150	S TACHY	140	90	94	150	155
65	1325618	T	36	OBSTRUCTIONAL HERNIA	27	F	III	II	2	<40	23.3	76.9	108	S TACHY	133	81	98	137	128
66	1328005	T	40	PERFORATED APPENDIX	20	M	III	III	2	<40	17.1	67.3	108	S TACHY	130	80	99	108	110
67	1332490	T	28	BOWEL PERFORATION	27	M	III	II	2	<40	56	95.1	140	S TACHY	138	78	93	130	132
68	1066503	T	61	SAIO	23	F	III	II	2	<40	33.8	86.3	86	NSR	172	94	94	170	175
69	1342743	T	45	SAIO	29.3	F	III	II	2	<40	17.1	67.3	108	S TACHY	134	80	99	130	129
70	363881	T	60	GIT OBSTRUCTION	29	F	III	III	2	<40	10.9	52	60	NSR	130	70	99	130	128
71	1344989	T	31	GIT OBSTRUCTION	20	M	IV	II	2	<40	43	91.1	122	S TACHY	128	72	98	135	135
72	1357409	T	42	GIT OBSTRUCTION	21	F	IV	III	2	<40	15.3	63.6	80	NSR	100	60	95	100	112
73	1319744	T	25	GUT injury	20	M	III	II	2	<40	9.7	48	89	NSR	114	74	100	140	138
74	1359826	F	66	GUT injury	26	M	III	II	2	<40	12.2	56	85	NSR	150	80	100	160	170
75	1359720	T	71	OBSTRUCTIONAL HERNIA	22	F	IV	III	2	<40	33.8	86.3	90	NSR	160	80	100	135	135
76	1290957	T	42	GIT OBSTRUCTION	23	M	III	II	2	<40	17.1	67.3	93	NSR	140	80	99	130	129
77	1346334	T	32	GIT OBSTRUCTION	22	F	III	II	2	<40	19	70.7	89	NSR	130	80	100	128	130
78	1366056	T	65	OBSTRUCTIONAL HERNIA	30	M	IV	III	2	<40	31	84.3	100	S TACHY	150	80	99	160	158
79	1353144	T	64	GIT OBSTRUCTION	22	M	IV	III	2	<40	18	79	90	NSR	140	80	100	110	104
80	1367684	F	39	GIT OBSTRUCTION	21	M	III	II	2	<40	21.1	73.9	90	NSR	150	80	100	130	132

SR NO.	MRD no.	SYSTOLIC NIBP									DIASTOLIC NIBP										SpO2						
		3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11 min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11 min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min
46	1231907	160	170	140	150	160	166	130	120	120	80	88	80	90	80	80	80	80	80	70	80	99	99	100	100	100	100	100
47	1232967	128	120	110	100	110	130	111	110	120	80	72	78	80	70	80	70	80	80	70	80	100	99	99	100	100	100	100
48	1195093	145	140	140	138	130	128	128	124	130	83	85	82	80	78	78	72	70	72	76	72	98	98	100	100	100	100	100
49	1128919	120	110	110	100	100	110	110	120	110	80	80	80	80	70	60	70	70	80	80	80	100	100	100	100	100	100	100
50	178901	154	145	154	142	140	138	132	132	130	80	84	89	89	96	79	78	70	72	72	70	96	97	97	100	68	67	60
51	1294887	129	120	125	125	100	110	80	90	100	80	70	74	70	70	63	53	50	50	60	70	88	89	90	100	99	100	100
52	370768	120	124	126	130	132	132	130	128	130	80	80	80	74	78	80	82	78	80	78	78	100	100	100	100	100	100	100
53	1254586	150	160	165	140	133	130	138	134	130	80	72	78	80	85	82	80	70	68	62	60	98	99	100	100	100	100	100
54	1252144	150	160	165	140	133	130	138	134	130	80	72	78	80	85	82	80	70	68	62	60	86	87	88	100	90	98	98
55	1279983	129	120	110	110	111	100	120	120	110	80	70	74	80	70	70	82	70	80	80	70	100	99	99	100	100	100	100
56	1280904	118	122	128	124	120	110	111	120	120	80	78	70	82	80	80	70	70	70	80	70	99	98	99	100	99	100	100
57	1000381	150	140	145	140	148	132	138	120	115	100	100	90	80	85	80	95	79	70	70	60	89	90	90	100	95	100	100
58	924330	128	120	110	110	100	90	110	100	120	80	70	78	80	80	70	60	60	60	70	80	95	95	96	100	99	100	100
59	1292753	124	120	110	120	130	120	120	110	111	90	78	72	70	70	80	80	80	80	70	60	99	99	100	100	100	100	100
60	1293628	110	110	100	90	110	112	111	100	120	70	68	68	70	60	50	70	72	72	70	80	99	99	99	100	100	100	100
61	1294887	130	128	122	120	126	116	110	111	110	80	82	70	70	70	70	76	66	60	72	70	83	82	83	100	90	92	92
62	1316455	129	120	125	125	100	110	80	90	100	80	70	74	70	70	63	53	50	50	60	70	100	100	100	100	100	100	100
63	1317504	128	136	140	142	150	138	140	138	136	80	82	72	78	82	80	84	78	80	82	74	100	100	100	100	100	100	100
64	1323343	150	140	145	140	148	132	138	120	115	100	100	90	80	85	80	95	79	70	70	60	94	95	95	100	99	100	100
65	1325618	135	140	150	166	118	110	98	104	102	84	83	96	80	90	105	73	70	60	60	60	98	100	100	100	100	100	100
66	1328005	112	100	92	80	100	110	111	114	120	64	70	60	60	62	60	60	60	66	64	80	98	99	100	100	100	100	100
67	1332490	128	136	140	142	150	138	140	138	136	80	82	72	78	82	80	84	78	80	82	74	93	94	94	100	94	92	95
68	1066503	168	170	175	172	168	166	169	160	155	100	102	98	98	100	92	90	82	80	80	82	94	95	95	100	100	100	100
69	1342743	120	110	110	100	100	110	110	120	110	80	80	80	80	70	60	70	70	80	80	80	99	99	100	100	100	100	100
70	363881	128	120	110	110	100	90	110	100	120	80	70	78	80	80	70	60	60	60	70	80	99	100	100	100	100	100	100
71	1344989	128	132	135	125	110	100	120	135	140	88	89	90	91	92	93	94	95	96	97	90	98	99	100	100	100	100	100
72	1357409	114	130	128	110	100	90	100	110	100	60	64	62	80	70	70	70	60	70	70	60	95	95	96	100	100	100	100
73	1319744	140	142	155	160	150	140	130	128	110	80	80	80	85	90	90	90	70	70	82	70	100	100	100	100	100	100	100
74	1359826	170	150	120	110	100	90	110	120	140	80	80	80	80	72	70	60	50	70	80	80	99	99	100	100	100	100	100
75	1359720	128	132	135	125	110	100	120	135	140	88	89	90	91	92	93	94	95	96	97	90	95	95	96	100	100	100	100
76	1290957	120	110	110	100	100	110	110	120	110	80	80	80	80	70	60	70	70	80	80	80	100	100	100	100	100	100	100
77	1346334	130	120	122	110	110	114	100	111	110	80	80	90	80	82	70	70	72	60	62	70	99	99	100	100	100	100	100
78	1366056	150	150	130	126	122	120	110	100	160	100	78	98	98	86	84	80	80	70	60	100	100	100	100	100	100	100	100
79	1353144	110	110	100	96	90	110	120	130	120	70	64	78	70	60	62	50	70	80	80	80	99	99	100	100	100	100	100
80	1367684	128	136	140	142	150	138	140	138	136	80	82	72	78	82	80	84	78	80	82	74	96	95	94	100	93	92	100

SR NO.	MRD no.	Heart rate																Attempts of laryngoscopy	Method of laryngoscopy	cormack lehane score	any rescue manoeuvre		Bl
		8 min	9min	10 min	11 min	12min	1MIN	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9min	10 min	11min				LMA	Bag and mask	SPO2 less than 90%
46	1231907	100	100	100	100	100	108	107	108	110	115	116	118	115	114	118	114	1	CONVENTIONAL	II	NO	NO	NIL
47	1232967	100	100	100	100	100	75	74	72	80	82	80	82	85	88	90	90	2	CONVENTIONAL	II	NO	NO	NIL
48	1195093	100	100	100	100	100	106	107	108	108	110	102	104	100	102	100	98	1	CONVENTIONAL	II	NO	NO	NIL
49	1128919	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	III	NO	NO	NIL
50	178901	54	65	70	85	90	105	103	101	103	105	105	110	112	115	117	110	1	VIDEOLARYNGOSCOPE	II	NO	yes	YES
51	1294887	100	100	100	100	100	103	102	104	107	97	94	90	85	86	80	88	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
52	370768	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	I	NO	NO	NIL
53	1254586	100	100	100	100	100	106	107	108	108	110	102	104	100	102	100	98	1	CONVENTIONAL	II	NO	NO	NIL
54	1252144	96	98	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
55	1279983	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
56	1280904	100	100	100	100	100	120	118	110	115	120	125	130	128	122	120	118	1	CONVENTIONAL	II	NO	NO	NIL
57	1000381	99	99	99	100	100	106	107	108	108	110	102	104	100	102	100	98	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
58	924330	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
59	1292753	100	100	100	100	100	103	102	104	107	97	94	90	85	86	80	88	1	CONVENTIONAL	I	NO	NO	NIL
60	1293628	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
61	1294887	96	96	99	99	99	106	107	108	108	110	102	104	100	102	100	98	1	CONVENTIONAL	II	NO	NO	NIL
62	1316455	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
63	1317504	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	2	CONVENTIONAL	II	NO	NO	NIL
64	1323343	100	100	100	100	100	120	118	110	115	120	125	130	128	122	120	118	1	CONVENTIONAL	III	NO	NO	NIL
65	1325618	100	100	100	100	100	106	107	108	108	110	102	104	100	102	100	98	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
66	1328005	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
67	1332490	96	100	100	100	100	70	75	78	87	94	93	88	87	91	90	90	1	CONVENTIONAL	II	NO	NO	NIL
68	1066503	100	100	100	100	100	85	88	89	90	95	99	100	112	110	111	112	1	CONVENTIONAL	II	NO	NO	NIL
69	1342743	100	100	100	100	100	102	103	106	104	109	108	110	108	110	111	115	1	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
70	363881	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
71	1344989	100	100	100	100	100	120	118	110	115	120	125	130	128	122	120	118	1	CONVENTIONAL	III	NO	NO	NIL
72	1357409	100	100	100	100	100	106	107	108	108	110	102	104	100	102	100	98	1	CONVENTIONAL	III	NO	NO	NIL
73	1319744	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
74	1359826	100	100	100	100	100	70	75	78	87	94	93	88	87	91	90	90	1	CONVENTIONAL	II	NO	NO	NIL
75	1359720	100	100	100	100	100	85	88	89	90	95	99	100	112	110	111	112	2	VIDEOLARYNGOSCOPE	III	NO	NO	NIL
76	1290957	100	100	100	100	100	102	103	106	104	109	108	110	108	110	111	115	2	CONVENTIONAL	III	NO	NO	NIL
77	1346334	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	2	CONVENTIONAL	III	NO	NO	NIL
78	1366056	100	100	100	100	100	82	80	84	78	76	80	86	84	80	82	80	1	CONVENTIONAL	II	NO	NO	NIL
79	1353144	100	100	100	100	100	120	118	110	115	120	125	130	128	122	120	118	2	CONVENTIONAL	III	NO	NO	NIL
80	1367684	100	100	100	100	100	106	107	108	108	110	102	104	100	102	100	98	1	CONVENTIONAL	II	NO	NO	NIL

SR NO.	MRD no.	aseline ABG values				After successful intuabtion					Experience of laryngoscopist in years				apnoea time	minimum spo2	vasopresser used	PAO2 (kPa) after intubation	PaO2 (kPa) baseline
		PaO2	PaCO2	Ph	HCO3	lactates	PaO2	PaCO2	Ph	HCO3	lactates	3-5 yrs	6-10 yrs	≥11 yrs	SECONDS		ml/hr(80mcg/ml)		
46	1231907	87	30	7.6	29	1.3	315	58	7.38	34.3	0.8	-	yes	-	116	99	nil	41.9	11.59
47	1232967	165	29	7.58	27.2	0.8	248	52	7.36	27.3	1.4	yes	-	-	70	99	nil	33	21.99
48	1195093	109	27	7.45	18.8	2.1	292	37	7.42	24	2.1	-	yes	-	72	99	nil	38.9	14.53
49	1128919	57	40	7.38	23.7	1.3	200	42	7.33	23.8	1.3	-	yes	-	120	90	nil	26.6	7.59
50	178901	80	29	7.45	20.2	0.5	69	44	7.31	22.2	0.5	-	yes	-	300	54	nil	9.1	10.66
51	1294887	52	53	7.31	26.7	0.6	255	60	7.25	26.3	0.5	-	-	-	130	88	nil	33.9	6.93
52	370768	104	35	7.53	29.2	0.7	333	38	7.5	29.6	0.7	-	-	-	70	100	nil	44.3	13.86
53	1254586	75	31	7.54	26.5	0.7	150	37	7.44	25.1	1	-	-	-	120	98	nil	19.9	9.99
54	1252144	55	32	7.34	18.8	1.8	234	44	7.23	18.3	1.8	YES	yes	-	90	87	nil	31.1	7.33
55	1279983	153	31	7.48	23.1	0.4	219	31	7.45	21.5	0.5	-	yes	-	120	97	nil	29.1	20.39
56	1280904	71	25	7.49	19.1	2.2	162	46	7.31	23.2	1.3	-	yes	-	75	98	nil	21.5	9.46
57	1000381	60	34	7.42	23.4	1.8	196	43	7.33	22.5	1.7	-	yes	-	91	89	nil	26.1	7.99
58	924330	68	38	7.5	29.6	1.7	391	54	7.37	31.2	1.3	-	yes	-	120	95	nil	52.1	9.06
59	1292753	80	32	7.47	23.3	1.8	202	45	7.34	24.3	1.9	-	yes	-	130	100	nil	26.9	10.66
60	1293628	124	35	7.39	21.2	1	175	49	7.23	20.5	1.4	-	yes	-	110	99	nil	23.3	16.53
61	1294887	52	53	7.31	24.3	0.6	255	60	7.25	23.5	0.5	-	yes	-	150	82	nil	33.9	6.93
62	1316455	120	32	7.39	21.2	1	160	42	7.23	20.5	1.4	-	yes	-	120	100	nil	21.3	15.99
63	1317504	337	28	7.56	25.1	0.9	278	38	7.48	28.3	0.8	-	yes	-	110	100	nil	37	44.92
64	1323343	68	36	7.45	25	2.2	346	58	7.26	26	2.1	-	yes	-	130	94	nil	46.1	9.06
65	1325618	92	32	7.46	22.8	1.3	399	41	7.39	24.8	1.5	-	yes	-	120	98	nil	53.1	12.26
66	1328005	80	33	7.48	24.6	1.3	315	54	7.33	28.5	1.5	-	yes	-	110	99	nil	41.9	10.66
67	1332490	67	23	7.46	16.4	2.9	66	43	7.29	20.4	2.4	-	yes	-	75	90	nil	8.7	8.93
68	1066503	89	29	7.47	23.6	1.1	289	46	7.33	24.3	1.1	-	yes	-	70	94	nil	38.5	11.86
69	1342743	95	38	7.5	29.6	0.6	244	48	7.44	32.6	0.6	-	yes	-	180	98	nil	32.5	12.66
70	363881	70	35	7.44	25	2.1	350	52	7.23	26	2.1	-	yes	-	120	99	nil	46.6	9.33
71	1344989	106	25	7.25	11	2.2	402	55	7.17	17.9	2.9	-	yes	-	90	98	nil	53.5	14.13
72	1357409	66	35	7.49	26.7	0.6	137	45	7.39	27.2	0.5	-	yes	-	100	94	nil	18.2	8.79
73	1319744	90	40	7.51	31.9	0.5	343	45	7.46	32	0.5	-	yes	-	120	95	nil	45.7	11.99
74	1359826	105	35	7.44	23.8	0.4	220	40	7.4	25.4	0.5	-	yes	-	120	99	nil	29.3	13.99
75	1359720	88	21	7.45	14.6	2.3	313	28	7.34	15.1	2.1	-	yes	-	110	96	nil	41.7	11.73
76	1290957	65	36	7.52	29	1.6	205	52	7.33	27.4	1.4	-	yes	-	90	99	nil	27.3	8.66
77	1346334	182	29	7.55	25.4	0.5	395	38	7.44	25.8	0.5	-	-	yes	110	97	nil	52.6	24.26
78	1366056	93	34	7.45	23.6	0.6	353	49	7.33	25.8	0.6	-	yes	-	100	99	nil	47.06	12.39
79	1353144	87	30	7.6	29	1.3	315	58	7.38	34.3	0.8	-	yes	-	120	99	nil	41.9	11.59
80	1367684	83	39	7.49	27.7	0.8	193	47	7.42	30.5	0.8	-	yes	-	90	98	nil	25.7	11.06

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb). INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Examination@bfuhs.ac.in

No. BFUHS/2K21p-TH/ 201

Date 6/11/2022

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Diksha**, a student of your college for **MD Anaesthesiology** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis

Transnasal humidified rapid-insufflation ventilatory exchange versus conventional facemask breathing for preoxygenation during rapid sequence induction in adults: a prospective randomized study.

Supervisor
Dr. Anju Grewal
Prof.,
Dep. of Anaesthesiology,
DMCH, Ludhiana.

Co-Supervisor

Dr. Kamakshi Garg
Assoc. Prof.,
Dept. of Anaesthesiology,
DMCH, Ludhian.a

Dr. Richa Jain
Asst. Prof.,
Dept. of Anaesthesiology,
DMCH, Ludhiana.

The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

S P S

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

13. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
14. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

TRANSNASAL HUMIDIFIED RAPID-INSUFFLATION VENTILATORY EXCHANGE VERSUS CONVENTIONAL FACEMASK BREATHING FOR PREOXYGENATION DURING RAPID SEQUENCE INDUCTION IN ADULTS: A PROSPECTIVE RANDOMIZED STUDY

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF MEDICINE

In

ANAESTHESIOLOGY

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH 2021

DIKSHA

DEPARTMENT OF ANAESTHESIOLOGY
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA
LUDHIANA, PUNJAB-141001

ABSTRACT OF PLAN OF THESIS

Title	Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study
For the degree of	M.D. Anaesthesiology
Name of the candidate	Dr. Diksha
Supervisor	Dr. Anju Grewal, Professor, Department of Anaesthesiology, DMCH, Ludhiana
Co-supervisors	Dr. Kamakshi Garg, Associate Professor, Department of Anaesthesiology, DMCH, Ludhiana Dr. Richa Jain, Assistant Professor, Department of Anaesthesiology, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Transnasal Humidified Rapid-Insufflation Ventilatory Exchange (THRIVE) if used for preoxygenation and apnoeic oxygenation has the propensity to extend the safe apnoea time and thereby decreasing the incidence of desaturation during Rapid Sequence Induction (RSI) for emergency surgeries. Hence, we propose to evaluate the comparative efficacy of preoxygenation with use of conventional facemask breathing versus THRIVE during RSI in patients undergoing general anaesthesia (GA) for emergency surgeries.

Aim of Study: To compare partial pressure of arterial oxygen (PaO_2) and the lowest peripheral oxygen saturation (SpO_2) between two groups.

Materials & methods: Patients undergoing RSI under GA for emergency abdomino-pelvic surgery will be allocated randomly into two groups. Patients will be preoxygenated for 3 minutes with 100% oxygen either via a high flow nasal cannula at flow of 60 L/min using THRIVE or via a tightly held snuggly fitting facemask at flow of 12L/min using a circle system. RSI will be administered followed by laryngoscopy and endotracheal intubation. PaO_2 will be measured immediately after successful endotracheal intubation. The lowest SpO_2, apnoea time, number of attempts at laryngoscopy, use of any rescue manoeuvres and any adverse event will be recorded.

Clinical Significance: Use of THRIVE preoxygenation can extend the safe apnea time thereby creating a safety net for enhanced patient safety.

Keywords: THRIVE (Transnasal Humidified Rapid-Insufflation Ventilatory Exchange), HFNC (high flow nasal cannula), Preoxygenation, Rapid Sequence Induction (RSI).

(Signature) Candidate	(Signature) Co-supervisor	(Signature) Co-supervisor	(Signature) Supervisor	(Signature) Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study"** exist in the Department of Anaesthesiology at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

Dr. Anju Grewal
Professor
Department of Anaesthesiology
DMCH, Ludhiana

Co-Supervisor

Dr. Kamakshi Garg
Associate Professor
Department of Anaesthesiology
DMCH, Ludhiana

Dr. Richa Jain
Assistant Professor
Department of Anaesthesiology
DMCH, Ludhiana

Head of the Department

Dr. Dinesh Sood
Professor & Head
Department of Anaesthesiology
DMCH, Ludhiana

Place : Ludhiana
Date :

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Diksha
Department	Anaesthesiology
Topic of Thesis	Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study
Likely date of appearing in PG examination	MAY-JUNE 2023
Date of enrollment	26th July,2020
Name of Head of Department	Dr. Dinesh Sood
1) Supervisor **2) Co-Supervisor**	Dr. Anju Grewal Dr. Kamakshi Garg, Dr. Richa Jain
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / No

Dr. Sandeep Puri
Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR. DIKSHA H/NO. 152/1 BABA FARID AVENUE JAIL ROAD, GURDASPUR
2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL, LUDHIANA
3	COURSE OF STUDY AND SUBJECT	M.D. ANAESTHESIOLOGY
4	DATE OF ADMISSION OF COURSE	26th July, 2020
5	TITLE OF THE TOPIC	Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Rapid sequence induction (RSI) is routinely performed for patients undergoing emergency surgeries[1], which can be a challenging situation for an anaesthesiologist because of the potential physiological and pathological derangements in these patients.[2] These physiological derangements predispose them towards a higher risk for developing hypoxia during RSI thereby limiting the safety margins during attempts to secure a definitive airway. Therefore, preoxygenation is mandatory for these critically ill patients as it not only denitrogenates the lungs but also increases the O_2 reservoir in the lungs thereby prolonging the safe apnoea period and reducing intubation related oxyhaemoglobin desaturation.[3]

Current practice employs the use of conventional facemask for preoxygenation at flow rates of oxygen upto 15 L/min. With maximal preoxygenation, the time to oxyhemoglobin desaturation below 80% can vary from 9 minutes in healthy non-obese adults to 3 minutes or less in children or obese adults.[4]

Patients undergoing emergency surgeries are usually full stomach, hence ventilation with conventional facemask during period of desaturation can increase the risk of gastric insufflation and pulmonary aspiration.[4] The combination of poor physiological reserves and risk of pulmonary aspiration mandates use of apnoeic ventilation along with optimal pre-oxygenation for safer conduct of RSI. Conventionally facemask preoxygenation along with use of nasal cannula for apnoeic ventilation at flow rates of > 15L/minute can result in patient discomfort, mucosal dryness and headaches.[5] In addition, this flow may not be adequate in maintaining oxygenation during RSI of these critically ill patients.

Transnasal Humidified Rapid-insufflation Ventilatory Exchange (THRIVE) has been recommended as an alternative method for preoxygenation and apnoeic oxygenation during RSI. THRIVE can deliver heated and humidified oxygen with FiO_2 ranging from 21% to

100% and flows upto 60-70L/min through specially designed high flow nasal cannula (HFNC).[6]

In a study conducted by Patel et al., THRIVE was used for both pre-oxygenation and apnoeic oxygenation in patients with features of difficult airway undergoing general anaesthesia for hypolaryngeal and orolaryngeal surgeries. An extended median apnoeic period upto 14 minutes was observed without any incidence of desaturation. They concluded that THRIVE extends the benefits of classic facemask preoxygenation and provides continuous positive airway pressure gaseous exchange through flow dependent dead space flushing.[5]

Mir et al. compared preoxygenation with conventional facemask and THRIVE in 40 patients undergoing RSI for emergency surgery and they observed that PaO_2 was similar in both the groups in spite of a significantly longer apnoea time in THRIVE group.[7] Later, Lodenius et al. also compared the preoxygenation method with conventional facemask and THRIVE in adult patients who required RSI for emergency surgery and reported lower number of patients desaturating below 93% in the group preoxygenated with THRIVE.[8] Thus incorporation of THRIVE for pre-oxygenation and continued oxygenation during apnoeic period might offer superior conditions during RSI.

We hypothesize that the use of THRIVE at 60 L/min for preoxygenation and apnoeic oxygenation will maintain a higher PaO_2 and SpO_2 when compared with current standard use of facemask preoxygenation. Hence, we have designed a randomized comparative study to evaluate the efficacy of preoxygenation with use of conventional facemask breathing and THRIVE during RSI in patients undergoing general anaesthesia for emergency surgeries.

6.2 REVIEW OF LITERATURE

Rapid sequence induction (RSI), a specialised method of intravenous (iv) induction of anaesthesia, is commonly employed for emergency surgeries[1] where an increased risk of gastric regurgitation and pulmonary aspiration of gastric contents exists. RSI consists of pre-oxygenation, administration of fixed doses of rapidly acting iv induction anaesthetics and neuromuscular blockers along with application of cricoid pressure which is followed by tracheal intubation without intermittent positive pressure ventilation.[9]

Cricoid pressure, eponymously referred to as Sellick manoeuvre after the physician who first described it, involves the application of pressure at the cricoid ring to occlude the upper oesophagus thereby preventing the regurgitation of gastric contents into the pharynx. The recommended force to be applied is 10 Newtons(N) while patient is awake, increased to 30 N after loss of consciousness.[9]

The goal of RSI is to achieve optimal intubating conditions rapidly to minimize length of time between the loss of consciousness and securing of the airway with a cuffed endotracheal tube. The term modified RSI is frequently used, but no standardized definition exists. In a survey by anaesthesia residents and attending anaesthesiologists in USA showed that the term was most commonly used to refer to the use of gentle mask ventilation in conjugation with cricoid pressure.[9]

Since patients undergoing emergency surgeries are at a higher risk for developing hypoxia and aspiration of gastric contents during the procedure of intubation, an anaesthesiologist gets limited time for securing airway. RSI is the preferred method, and pre-oxygenation is mandatory for these critically ill patients as it not only denitrogenates the lungs but also prolongs the safe apnoea period during tracheal intubation. Pre-oxygenation increases the O_2 reservoir in the lungs to reduce intubation related oxy-haemoglobin desaturation.[3] Despite adequate conventional preoxygenation, these critically ill patients may experience episodes of significant desaturation.

Critically ill patients have a shorter safe apnoeic time due to physiological stressors that accompany critical illnesses, such as decreased cardiac output, increased shunting, and reduced pulmonary reserves.[10] Oxygen saturation in these patients can rapidly drop to a critical hypoxic state of less than 70% within seconds.[11] Furthermore, with increasing prevalence of obesity both locally and worldwide,[12] the safe apnoeic time is further shortened. It is estimated that a moderately ill normal-sized adult would reach an oxygen saturation (SpO_2) of 90% at slightly within 5 minutes, while a 127-kg obese adult would reach such a level within 2.5 to 3 minutes.[13]

Prolongation of safe apnoea time and adequate pre-oxygenation would ameliorate some of these negative outcomes by preventing hypoxia and allowing more time to achieve successful intubation. Current practice employs the use of conventional facemask for pre-oxygenation usually at 15 L/min. Insufficient heating and humidification with this technique leads to poor tolerance due to complaints, especially dry nose, dry throat and nasal pain.[5] With use of conventional devices, oxygen flow is limited to no more than 15 L/min while the inspiratory flow of critically ill patients may vary widely from 30 L/min to more than 100 L/min. The difference between patient's inspiratory flow and delivered flow is large, and as a result, FiO_2 delivered is both inconstant and often lower than expected.[6]

Thus, the current usual practice of pre-oxygenation using conventional facemask and nasal cannula for apnoeic oxygenation may not be adequate in maintaining oxygenation during RSI of critically ill patients.[14]

THRIVE has been recommended as an alternative method for pre-oxygenation and apnoeic oxygenation during RSI .It can deliver heated and humidified oxygen with FiO_2 ranging from 21% to 100% and flows upto 60L/min through specially designed high flow nasal cannula (HFNC).[6]

HFNC was first developed for use in neonates. Although many adult patients found the use of a close fitting mask not particularly tolerable, the most common issue in the adult population usually remained clearance of airway secretions[15]. HFNC was thus originally developed with the intention of maintaining the benefit of high oxygen flows (and thus the increased end-expiratory pulmonary pressures) without compromising blood flow to skin areas susceptible to pressure sores which is associated with the use of facemask.[16]

Over the last 10 years, HFNC has had widespread use in the adult population as it can provide non invasive ventilation with little discomfort to the patient.[17] However, there is still much debate regarding the role of the HFNC in the management of critically ill patients and only recently some better quality research has emerged on the topic.

Most of the benefits of HFNC are attributed to generation of modest levels of positive airway pressure. A study performed in human volunteers undergoing elective cardiac surgeries demonstrated that high flows delivered through HFNC generated positive airway pressures in the nasopharynx (<3 cmH_2O), which despite being relatively low compared to those generated easily in closed systems, could prevent alveolar closure.[18] However, concern has been raised that this positive airway pressure may cause gastric insufflation, potentially increasing the risk of regurgitation and aspiration in an unprotected airway.

Elizabeth McLellan et al. conducted a prospective, interventional, assessor-blinded study to evaluate the effects of high flow nasal oxygenation (HFNO) on gastric content and gastric distension in healthy fasting adult volunteers assessed by ultrasonography. The primary outcome was the volume of gastric secretions. The secondary outcomes were the incidence of gastric air insufflation and the distribution of gastric antral grades. Sixty subjects were enrolled who were asked to fast from solids for 8 hours and clear liquids 2 hours. No

subject was found to have air gastric distension either at baseline or after treatment with HFNO at 70L/min for 30 minutes. All subjects had either a Grade 0 or Grade 1 antrum, with similar distribution of antral grades and similar volume of gastric secretions before and after treatment with HFNO.[19]

Theoretical benefits of THRIVE have led to attention of many towards its use of in various situations demanding longer safe apnoea time. Various studies have been conducted for comparative evaluation of the safety and efficacy of THRIVE with conventional facemask as preoxygenation method.

In 2015, A. Patel et al. conducted a study on THRIVE on 25 patients with difficult airway undergoing hypopharyngeal and laryngeal surgeries. There were 12 obese patients and nine patients were stridulous. Continuous delivery of transnasal high-flow humidified oxygen, initially to provide pre-oxygenation, and then continuing as post-oxygenation during intravenous induction of anaesthesia and neuromuscular blockade until a definitive airway was secured was performed. The median apnoea time was 14 min and no patient experienced arterial desaturation < 90%.[5]

In 2016, a study was conducted by Mir et al. comparing pre-oxygenation with conventional facemask and THRIVE in 40 patients undergoing RSI for emergency surgery. Pregnant females and patients with severe cardiorespiratory disease were excluded. Patients in the THRIVE group were preoxygenated with high flow nasal cannulae with flow started at 30 L/min over one minute and then increased to 70 L/minute until the placement of tracheal tube whereas patient assigned with the conventional facemask were preoxygenated for 3 minutes using a circle system with an oxygen rate of 12 L/minute. Primary outcome was PaO_2 and they found that PaO_2 was similar in both the groups in spite of a significantly longer apnoea time in THRIVE group.[7]

In 2017, Santi Maurizio Ranieri conducted a study on efficacy and safety of using HFNC in patients undergoing RSI. Patient aged

>18years who required RSI in general anaesthesia for urgent /emergency abdominal surgeries were taken and patients who were pregnant; affected by acute coronary syndrome or significant cardiovascular disease; had obstructive sleep apnoea syndrome (OSAS) with or without ventilator support, with oro-tracheal or rapid-induction contraindications were excluded. HFNO of 60 L/min at an inspiratory oxygen fraction of 1 was delivered 4 min before laryngoscopy and maintained until the patient was intubated, and correct intubation was verified by the appearance of the end-tidal CO_2 ($EtCO_2$) waveform. Minimal SpO_2 recorded was 96%; no patient showed SpO_2 of <3% from baseline; $EtCO_2$ at the time of endotracheal intubation was 36±4 mmHg and maximum apnoea time was 12 min.[20]

In 2018, Lodenius et al. also compared the pre-oxygenation method with conventional facemask and THRIVE in adult patients who required RSI for emergency surgery and exclusion criteria were body mass index (BMI) > 35 kg/m^2, pregnancy, a need for non-invasive ventilation to maintain oxygenation, or inability to give consent. They found lower incidence of patients desaturating below 93% in the group preoxygenated with THRIVE.[8] Thus, THRIVE might also offer superior conditions for pre-oxygenation over conventional facemask during RSI.

Another study was conducted by Rajan S et al. in 2018 to compare time to desaturate to <90% during apnoea with THRIVE versus traditional preoxygenation followed by apnoeic oxygenation. This prospective, randomized, single-blinded study was conducted in 10 adult ASA physical status I and II patients presenting for direct laryngoscopy under general anaesthesia without endotracheal intubation. Patients with room air O_2 saturation <98%, anticipated difficult airway, chronic obstructed pulmonary disease, obesity, pregnancy, thyrotoxicosis, pheochromocytoma, hyperkalemia, significant cardiac illness with pulmonary hypertension and raised intracranial pressure were excluded from the study. Group P patients were preoxygenated with 100% oxygen, and in Group H, high-flow humidified oxygen was delivered using nasal cannula for 3 minutes.

After induction and neuromuscular blockade, time to desaturate to 90%, while receiving apnoeic oxygenation was noted .Group H had a significantly longer apnoea time as compared to Group P. All patients in Group H continued to have nearly 100% saturation even at 12 min of apnoea. However, in Group P 80% of patients desaturated to <90% after 6 minutes of apnoea.[21]

Therefore, we hypothesize that the use of THRIVE at 60L/min for pre-oxygenation and apnoeic oxygenation will maintain a higher PaO_2 and SpO_2 when compared with current standard use of facemask pre-oxygenation. Hence, we designed a randomized comparative study to evaluate the efficacy of pre-oxygenation with both conventional facemask ventilation and THRIVE during RSI in patients undergoing emergency surgery under general anaesthesia.

6.3 AIMS AND OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVE:

To compare the partial pressure of arterial oxygen (PaO_2) at the end of successful endotracheal intubation between the two groups.

SECONDARY OBJECTVE:

To compare the lowest SpO_2 values achieved during intubation between the two groups.

7. MATERIALS AND METHODS

7.1 SOURCE OF DATA

The study will be conducted in the department of Anaesthesiology, Dayanand Medical College & Hospital, Ludhiana after approval by the Institutional Ethics Committee on adult patients undergoing emergency abdomino-pelvic surgeries under general anaesthesia during the time period from 2021 to 2022. These patients will be randomly allocated to either of the two study groups each by computer generated random numbers contained in sealed, sequentially numbered envelopes. A written informed consent will be obtained from each patient.

7.2 METHOD OF COLLECTION OF DATA

Inclusion criteria:

- Patients who require rapid sequence induction (RSI) during general anaesthesia for urgent/emergent abdomino-pelvic surgeries.
- Patients aged 18 years and above, who are competent to give informed consent.

Exclusion criteria

- Pregnant females at any gestational age.
- Patients with severe cardio-respiratory disease.
- Clinical suspicion or confirmed diagnosis of base of skull fracture or severe facial trauma that precludes nasal cannula placement.
- Contraindications to the rapid sequence induction, if any (e.g. already intubated patients)**.**
- BMI ≥40kg/m^2
- Patients with laryngotracheal stenosis or benign or malignant hypopharyngeal obstruction.

GROUP ALLOCATION

Patients undergoing RSI under general anaesthesia for emergency abdomino-pelvic surgery during the time period from 2021 to 2022 will be recruited for the study and an equal number of patients will be allocated randomly using computer generated random number list to either of the following two groups.

GROUP T (THRIVE group): Patients will be preoxygenated for three minutes with heated and humidified 100% oxygen via a high flow nasal cannula at flow of 60 L/min using Transnasal Humidified Rapid-insufflation Ventilatory Exchange (THRIVE) and this flow will be maintained until successful placement of the tracheal tube.

GROUP F (Facemask group): Patients will be preoxygenated for three minutes with 100% oxygen via a tightly held snuggly fitting facemask at flow of 12 L/min using a circle system and this flow will be maintained till laryngoscopy is attempted.

PRE-ANAESTHETIC CHECKUP

Routine thorough check-up will be conducted comprising of detailed history, comorbidities, allergy to any drug being used, general physical and systemic examination. Patients will be explained about the study being conducted and written informed consent will be taken. Demographic information and preoperative variables including age, gender, BMI, ASA physical status, modified Mallampati grade, indication for surgery, preoperative Arterial Blood Gas (ABG) values and Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (P-POSSUM)[7] will be recorded.

ANAESTHESIA TECHNIQUE

On arrival in the operating room, the patients will be positioned on the operating table in the supine position and routine monitoring in the form of 5-lead electrocardiography, non-invasive blood pressure (NIBP) using an automated non-invasive device and pulse oximetry will be instituted. Continuous monitoring of heart rate (HR), blood pressure (cycled to 1 minute interval) and SpO_2 will be done and mean of three consecutive readings at one minute interval will be recorded as baseline. An arterial catheter will then be placed in the radial artery under local infiltration anaesthesia. An arterial ABG sample if clinically indicated will be sent.

Patients will be preoxygenated with 100% oxygen for 3 minutes using the method randomly allocated to him/her. Patients in group T will be preoxygenated with heated and humidified 100% oxygen delivered via a high flow nasal cannula at an oxygen flow of 60 L/min using THRIVE

while in group F patients will be preoxygenated with 100% oxygen via a tightly held well fitting facemask at an oxygen flow of 12 L/min using a circle system. Patients in both the groups will be maintained on jaw thrust to ensure airway patency throughout the period of apnea. If nasogastric tube is in situ then it shall be attached to continuous low grade suction to decompress the stomach.

RSI shall be accomplished using intravenous (IV) etomidate (0.2 to 0.4 mg/kg) and fentanyl (2µ/kg) followed by administration of neuromuscular blocker (rocuronium 1mg/kg or succinylcholine 1.5 mg/kg as per patient profile). Cricoid pressure (starting from 10N to a maximum of 40 N) will be applied as the patient becomes drowsy by a trained assistant.

In group T oxygen flow will remain at 60 L/min . Group F patients will continue to receive oxygen flow at 12L/min through face mask, and bag and mask ventilation will not be performed. One minute after the administration of the neuromuscular blocker, laryngoscopy will be performed by an experienced anaesthesiologist and airway will be secured by an appropriate size endotracheal tube. After confirming successful tracheal intubation by well-formed four capnography waveforms on monitor, an ABG sample from the arterial catheter in situ will be sent. Continuous monitoring of heart rate (HR), blood pressure (cycled to 1 minute interval), $EtCO_2$ and SpO_2 with waveform tracing will be recorded at one minute interval at all times after recording baseline value, until five minutes after intubation.

Gentle intermittent positive pressure ventilation limiting the inflation pressure to 15cm H_2O using bag mask ventilation will be instituted as a rescue in an event of desaturation to SpO_2 < 90% during RSI. If bag mask ventilation is ineffective, an appropriate sized second generation Laryngeal mask airway (LMA) will be inserted to rescue desaturation. Laryngoscopy and endotracheal intubation will be commenced after SpO_2 ≥98% in the above eventually.

FOLLOWING OBSERVATIONS WILL BE RECORDED:

PRIMARY OUTCOME:

Partial pressure of arterial oxygen (PaO_2): PaO_2 will be measured from the arterial blood gas sample obtained immediately after successful endotracheal intubation.

SECONDARY OUTCOMES:

1. **Lowest SpO_2**: SpO_2 will be monitored and recorded at one-minute interval throughout the study period. The lowest SpO_2 measured from the measurement of baseline SpO_2 value until 5 minutes after endotracheal intubation will be recorded.
2. **Apnoea time**: Apnoea time will be recorded. It is defined as the period from the start of apnoea assessed visually in the THRIVE group and when the capnography trace disappeared in the facemask group till the appearance of well-formed waveform capnogram immediately after tracheal intubation. If a drop in SpO_2 to $\leq$ 90% occurs during the study period necessitating manual ventilation, this will be recorded as the end of apnea.
3. **Number of attempts at laryngoscopy** will be recorded. Each attempt is defined as the passage of laryngoscope through the mouth**.**
4. **Use of any rescue manoeuvres** including bag and mask ventilation or use of second-generation laryngeal mask airway for ventilation will be recorded.
5. **Adverse events** like drop in SpO_2 ($\leq$90%), haemodynamic instability like drop in MAP <20% from baseline and use of vasopressors if any will also be recorded.
6. P-POSSUM will be calculated using an online calculator.

Statistical analysis:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the study groups will be done using Student t-test and Mann Whitney U test for independent samples for parametric and non-

parametric data respectively. For comparing categorical data, Chi square ($\chi 2$) test will be performed and exact test was used when the expected frequency is less than 5. A probability value (p value)less than 0.05 will be considered statistically significant. All statistical calculations will be done using (Statistical Package for the Social Science) SPSS 21version (SPSS Inc., Chicago, IL, USA) statistical program for Microsoft Windows

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached herewith

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PROFORMA

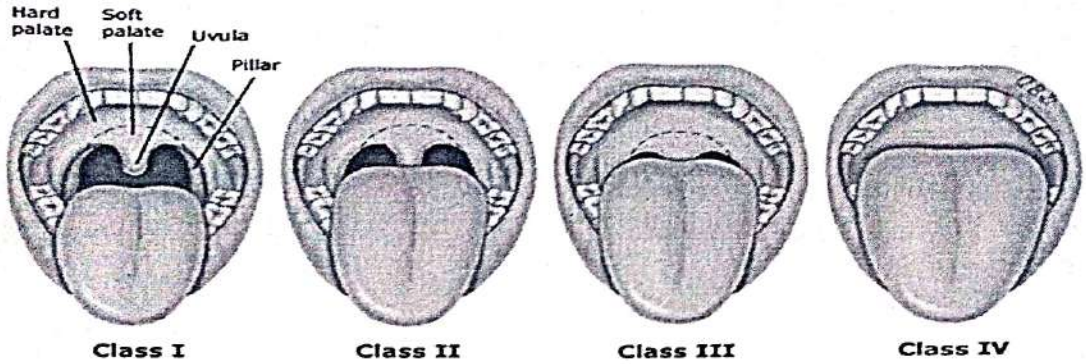
Serial no: MRD No: Group:

Date: Indication of Surgery:

Age: Gender: M/F BMI:

ASA Physical Status:

Airway- Modified Mallampati Score



Upper Lip Bite Test : Neck Circumference:

P-POSSUM SCORE :

PHYSIOLOGY SCORE	OPERATIVE SEVERITY SCORE
CARDIAC SIGNS • No failure • Diuretic , digoxin or angina/hypertension meds • Peripheral oedema ,warfarin,or borderline cardiomegaly on Chest X ray(CXR) • Raised juglar venous pressure ,or cardiomegaly on(CXR) : **Respiratory** • No dyspnea • Exertional dyspnea or mild COPD on CXR • Limiting dyspnea or moderate COPD on CXR • Dyspnea at rest or fibrosis/consolidation on CXR	Operative severity score o Operative severity ; See about section for example surgeries in each category ➢ Minor ➢ Moderate ➢ Major ➢ Major+ • Number of procedures ➢ 1 ➢ 2 ➢ >2 • Estimated blood loss in ml • Peritoneal soiling ➢ None ➢ Minor ➢ Local pus ➢ Free bowel content, pus or blood

Signature of Candidate Signature of Supervisor

	• Presence of malignancy ➢ Diagnosed before or during surgery ➢ None ➢ Primary only ➢ Lymph node mets ➢ Distant mets • Mode of surgery ➢ Elective ➢ Emergency.
• SBP • HR • GCS • Hgb • WBC • BUN • Na+ • K+2 • ECG; ➢ Normal ➢ Atrial fibrillation(HR 60-90) ➢ 5 ectopic beats/min,Q waves or ST/T wave changes ➢ Any other abnormal rhythm	
Calculated P POSSUM Score:-	
Predicted Mortality%= Morbidity%=	

I Baseline Haemodynamic and Respiratory Parameters

Time	1min	2min	3min	Mean
Heart rate/min				
ECG rhythm				
NIBP(mmhg)				
SpO_2(%) On oxygen[FiO_2]				

Signature of Candidate

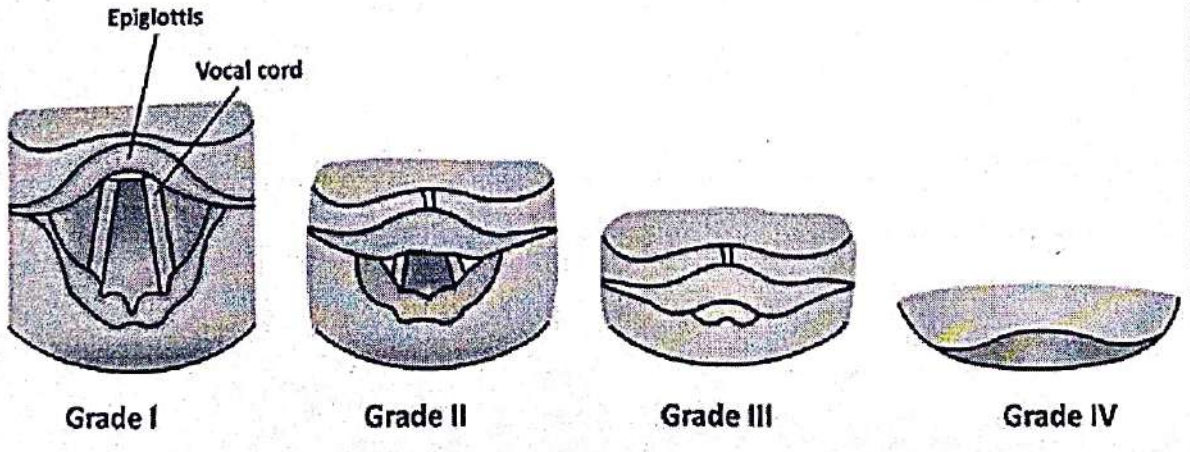
Signature of Supervisor

II Haemodynamic and Respiratory Parameters from pre-oxygenation till 5 minutes after successful intubation

TIME (at 1 minute interval)	NIBP(mmHg)	SpO_2(%)	HR/minute	$EtCO_2$(mmHg)	Vasopressor if used in mg

III Number of attempts of laryngoscopy:

IV Cormack -Lehane Score on first attempt of laryngoscopy:



Signature of Candidate

Signature of Supervisor

V Any rescue manoeuvre used For ventilation: YES/NO

- Bag and mask : YES \NO
- LMA : YES\NO

VI RECORDING OF VARIOUS TIMELINES:

a) Time of recording baseline parameters: _____
b) Time of induction of anaesthesia : _____
c) Time at which loss of $EtCO_2$ tracing or visible breathing ceases during RSI: _____
d) Time at which successful placement of endotracheal tube confirmed (4 well formed waveforms on capnography) : _____
e) Time of ABG sampling after successful intubation: _____
f) Time at which SpO_2 value was <90% during study period: _____

VII

ABG VALUES	Baseline	After successful intubation
PaO2		
PaCO2		
Ph		
Hco3		
Lactate		

VIII Experience of Laryngoscopist (in years):

3-5 YEARS	
6-10 YEARS	
≥11 YEARS	

IX Apnoea time: _____

X Minimum SpO_2 observed during study period: _____

XI Total amount of vasopressor used (in mg) if any: _____

Signature of Candidate

Signature of Supervisor

INFORMED PATIENT CONSENT

Date: _____

I.....D/o,W/o,S/o.....
.....am willing to participate in the study **"Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

.....
Signature of the Witness

Name:

.....
Signature of the patient

Signature of Supervisor

Signature of Candidate

मरीज अनुमति फार्म

तिथि _____

मैं _____पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य **"Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____ਵਾਸੀ

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"Transnasal Humidified Rapid-Insufflation Ventilatory Exchange versus Conventional Facemask Breathing for Preoxygenation during Rapid Sequence Induction in Adults: A Prospective Randomized Study" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ